# EFFICIENCY AND TREATMENT OUTCOME OF CORTICOTOMY ASSISTED ORTHODONTICS

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# CERTIFICATE

This is to certify that this dissertation title **"EFFICIENCY AND TREATMENT OUTCOME OF CORTICOTOMY ASSISTED ORTHODONTICS"** is a bonafide record of work done by **Dr. VIJAYASHRI SAKTHI S.** under my guidance during her postgraduate study period 2010–2013.

This dissertation is submitted to **THE TAMIL NADU Dr. M.G.R. MEDICAL UNIVERSITY**, in partial fulfillment for the degree of **Master of Dental Surgery** in Branch V – Orthodontics and Dentofacial Orthopaedics.

It has not been submitted (partially or fully) for the award of any other degree or diploma.

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## CONTENTS

## ABSTRACT

Bimaxillary protrusion is a condition warranting retraction of upper and lower incisor for optimizing their axial inclination to obtain lip competency and for straightening the profile. These cases generally require maximum conservation of anchorage since the entire retraction space must be utilized for retracting the incisors. Further adults who have bimaxillary proclination often express a desire to expedite the duration of treatment. In recent times corticotomy has been reported to be a viable proposition especially in adults who are desirous of reduced treatment duration. Most of the currently used corticotomy procedure has to be done under conscious sedation or general anesthesia and many of these techniques are invasive. The challenge in treating bimaxillary case is during retraction stage wherein the anchorage can be severely taxed, in addition this stage requires protracted treatment time. The current study employed a modified corticotomy protocol which utilizes the principle of Regional acceleratory phenomenon, in addition Demineralized freeze dried bone was also used to augment the periodontal apparatus. The current modification is relatively simple, less invasive and can be done under local anesthesia as an outpatient procedure. Extraction of premolars just prior to retraction in our approach also provides for maximum space for retraction of incisors.

The aim of the study was to compare the space closure in adults with modified corticotomy assisted orthodontic protocol and compare the treatment outcome in patients with similar malocclusion where corticotomy was not employed. The results conclusively prove that modified corticotomy procedure utilizing selective alveolar decortication is effective for retraction,reduces the retraction time by half in addition to conserving anchorage.



**Key words**: Adult orthodontics; Orthodontic retraction; Corticotomy; Regional acceleratory phenomenon.

# INTRODUCTION

Bimaxillary protrusion is a condition characterized by protrusive and proclined upper and lower anterior teeth and an increased procumbency of the lips.[43] Many patients with bimaxillary protrusion seek orthodontic treatment to decrease this procumbency.[8] Extracting the first four premolars and retracting the anterior segments with maximum anchorage is the most common way to reduce lip protrusion and to straighten the patient's profile.

However, during retraction, the characteristics of the anterior alveolar bone can resist the efforts to remodel bone. The anatomic limits set by the cortical plates of the alveolus at the level of the incisor apices act as barriers to incisor retraction. Also, orthodontic treatment requiring closure of extraction space, has side effects such as bone loss,[7,34,93,94] root resorption,[7,34] gingival recession,[7] root dehiscence,[92,66] and fenestration.[92,66] The mandibular incisors, more frequently than the maxillary incisors, is the limiting factor in treatment because of the thinness of their alveolar housing.[7]

One way to overcome this limitation is to use anterior segmental osteotomy.[93] This procedure is believed to provide optimal retraction of the anteriors and reduce the duration of treatment. Still its post operative complications and underlying surgical procedure under general anesthesia is considered unacceptable by many patients.[66,14]

Adult patients who seek orthodontic treatment often desire that their treatment be completed in as short a period as possible.[53] At present, however, adult patients with bimaxillary protrusion requiring maximum anchorage require at least 2 years of active treatment.[100]

In 1959, Köle[94] introduced a technique called selective alveolar decortications to enable movement of a bone segment that included a tooth by sectioning the layer of compact bone. In 2001, Wilcko et al[94,67] developed a new treatment method combining corticotomy, alveolar augmentation, and orthodontic treatment. They have observed that orthodontic tooth movement is accelerated by the increase of bone turnover and decrease of bone density because osteoclasts and osteoblasts are increased due to a regional acceleratory phenomenon (RAP).[26,98]

One possible method for completing treatment in a shorter period is through orthodontic treatment combined with corticotomy.[94,24,27,10] Corticotomy has been used in difficult adult cases as an alternative to conventional orthodontic treatment or orthognathic surgery. This period of accelerated tooth movement usually being 4 -6 months[94,83,27,9] has provided orthodontist an excellent opportunity to reduce the duration of treatment.

At present, the studies of corticotomy-facilitated orthodontics in bimaxillary protrusion are limited with regard to the efficient retraction time, period of accelerated tooth movement, rate of retraction and anchorage control.

Thus the aim of the present study is to assess the efficiency of treatment outcome of patients treated with corticotomy assisted en-masse orthodontic retraction with a modified protocol as compared with the en-masse retraction without corticotomy.

# REVIEW OF LITERATURE

**Calvin C.Case (1897)**[42] coined the term bimaxillary protrusion in his textbook published in 1921. He devoted an entire chapter to bimaxillary protrusion and retrusion. "Probably no other dentofacial malocclussion", he states, "so often mars or deforms the human face as some gradation of these two characters, bimaxillary protrusion and retrusion". He describes the condition in which the entire dentition of both jaws are protruded in relation to the mandible and other bones of the skull, and states that this deformity is always aggravated by a receding chin.

**Samuel J Lewis (1943)**[42] stated that bimaxillary protrusion is a condition in which the maxillary and the mandibular incisor teeth protrude severely so that the lips cannot be closed together. The condition is usually considered as an Angle Class I, and the anterior teeth are well aligned. However, it sometimes shows either mild crowding or spacing or mild vertical discrepancies ranging from an openbite to a deep bite.

**Lew et al (1989),**[42] **Keating PJ et al (1985)**[35] observed that the facial esthetic problems related to bimaxillary protrusion include extreme protrusion of the anterior teeth, lip incompetence, and strain with hypermentalis action on closure, thick looking lips with an everted vermilion border, and a toothy appearance due to an apparent chin deficiency. This profile is found predominantly in Africans and Asian adults—including the Chinese and the Japanese—and in Caucasians. The faces of Asians and peoples of African descent are more prominent than those of Caucasians. The Chinese generally have a greater tendency toward dentoalveolar protrusion than Caucasians or even the Japanese.

**Ballard (1963)**[3] discussed the aetiology of bimaxillary protrusion and considered it to be of multifactorial origin consisting of a genetic component as well as environmental factors, such as mouth breathing, tongue and lip habits, and tongue volume.

**Charles H. Tweed (1941)**[86] stated that, the most unstable and the most difficult condition to retain successfully are those in which both the maxillary and mandibular teeth are too far forward in relation to their respective bases.

**Miyawaki S. 2000, Yamazaki T et al (1998)**[53,100] proposed that adult patients who seek orthodontic treatment often desire that their treatment be completed in as short a period as possible. At present, however, adult patients with bimaxillary protrusion requiring maximum anchorage usually requiring atleast 2 years of active treatment.

**Bills D A et al (2005)**[3] examined the success of treatment involving four premolar extractions in the treatment (of 48 ethnically diverse patients) with bimaxillary protrusion. The study also showed that the extraction of four premolars can be extremely successful in reducing the dental and soft tissue procumbency seen in patients with bimaxillary protrusion, thus providing a stronger evidence-based rationale for this treatment modality.

**Lew (1989)**[42] looked at profile changes after the extraction of four first premolars and orthodontic treatment of bimaxillary protrusion in 32 Asian adults.

He reported significant improvement in upper and lower incisor protrusion, nasolabial angle, upper and lower lip length, and upper and lower lip protrusion.

**Cristopher JW(2004)** reviewed research work on dental and lateral profile soft tissue effects of the orthodontic treatment involving the premolar extraction patterns (1) upper and lower premolars, (2) upper first and lower second premolar, (3) upper and lower second premolars. In all the groups a mean reduction in the incisor protrusion was reported in all the first premolar extraction groups. Wide range of variation was found in the amount of forward molar movement and incisor retraction. The factors other than just the choice of premolar extraction influence the positional changes of the lips at the vermillion level.

Considering the above factors the review of literature for this study is categorized into three groups:-

1. En-masse retraction in orthodontics
2. Interventions for accelerating orthodontic tooth movement
3. Corticotomy assisted orthodontics

## 1. En-Masse Retraction in Orthodontics

**Tweed (1943)**[86] proposed that for minimizing anchorage loss and maximizing tooth movement efficiency, emphasized anchorage preparation as the first step in orthodontic treatment.

**Proffit and Fields (2000)**[61] recommended separate canine retraction for maximum anchorage, stating that this approach would allow the reaction force to be constantly dissipated over the large periodontal ligament area in the anchor unit. They acknowledged, however, that closing the space in two steps rather than in one would take nearly twice as long.

**Roth (1994)**[25] also recommended separate canine retraction for maximum anchorage extraction cases but did not recommend it for moderate ones.

**Kuhlberg (2001)**[40] described separate canine retraction as less taxing on anchorage because the two canines are opposed by several posterior teeth in the anchor unit.

**Staggers and Germane(1991)**[81] On the other hand, described anchorage as being taxed twice with a two step retraction, as opposed to once with en masse retraction, pointing out that the posterior segment is unaware of knowing how many teeth are being retracted and merely responds according to the force system involved.

**Wook Heo (2007)**[96] study was performed to determine whether two-step retraction provides better anchorage preservation than en masse retraction, No significant differences existed in the degree of anchorage loss of the upper posterior teeth and the amount of retraction of the upper anterior teeth associated with en masse retraction and two-step retraction of the anterior teeth.

Among the different space closure (anterior retraction, posterior protraction, or combination) options which are available today in preadjusted mechanotherapy, sliding mechanics for en masse retraction have gained a substantial popularity particularly after the evolution of MBT philosophy. Currently there are several commonly used methods of applying this force: these are elastic modules[25], elastic chain or active modules is the significant force decay over time.[26-28] NiTi springs have the reported advantage of giving significantly quicker and more consistent rates of space closure.[25,29,30]

**V.Dixon (2002)**[89], Compared the rates of orthodontic space closure for: Active ligature, polyurethane powerchain and Nickel titanium springs. Mean rates of space closure was 0.35mm/month for active ligatures, 0.58mm/month for powerchain and 0.81mm/month for NiTi springs, showing that NiTi springs gave the most rapid rate of space closure.

**Samuels RHA (1998)**[69] conducted a clinical study of space closure with nickel titanium closed coil spring and elastic modules. The study used sliding mechanics of pitting the six anterior teeth against the second bicuspid and first molars to examine rate of space closure of 100gms and 200gms nickel titanium closed coil springs. The result for three springs and elastic module were compared. The nickel-titanium closedcoil spring produced a faster rate of space closure than the elastic module. The 150 and 200 gms springs produced a faster rate of space closure than the elastic module or the 100gms spring. No significant difference was noted between the rates of closure for the 150gms and 200gms springs.

**Brig SM Londhe (2010)**[6] studied the efficacy of inclusion of second molar in treatment at the outset to reinforce anchorage. The study successfully quantified the anchorage loss and brought out the advantages of including second molar in treatment at the outset. Not only the anchorage loss is minimized but inclusion of second molar also helps to maximize incisor retraction and helps control angular movement of molar and incisor. Extra time required for second molar banding is well spent, as the benefits are overwhelming.

## 2. Interventions for Accelerating Orthodontic Tooth Movement

**Effects of pharmacological agents on tooth velocity:**

**Verna et al (2000)**[90] experimented on rats undergoing maxillary molar mesial movement, by inducing either hypothyroidism or hyperthyroidism. In rats with high bone turnover, the rate of tooth movement was increased, while it was reduced in animals with a low turnover group. Examination of histological sections from the jaws of these rats showed that root resorption had occurred in both groups, but that it was more pronounced in the low bone turnover group.

**Yamasaki et al (1984)**[99] injected prostaglandin E1 into the gingiva of moving teeth in rats and in human subjects, resulting in rapid movement.

**Sekhavat et al( 2002)**[70] had done a systemic application of misoprostol, PGE1 analog, to rats undergoing tooth movement for 2 weeks increased significantly the velocity of movement without enhancing root resorption.

**Madan et al( 2007)**[51] had done experimental application of the hormone relaxin to rats undergoing tooth movement. Maxillary molars were moved for 2–9 days, with or without relaxin application. Tooth velocity was found to be similar in both groups. However, relaxin reduced the level of PDL organization and mechanical strength, leading to increased tooth mobility.

**Acceleration of tooth velocity with physical stimuli:-**

**Tweedle (1965)**[88] used local application of heat to paradental tissues surrounding orthodontically treated teeth in dogs and found a relatively faster tooth movement.

**Miyoshi et al (2001)**[54] conducted experiments on rats which were exposed to light for 24 or 12 hrs per day for 21 days while subjected to orthodontic force during the light periods. The teeth in the 24 hrs light group presented doubling of the rates of tooth movement and bone remodeling, as compared with animals that received the force during the 12 hrs of daily darkness.

**Limpanichkul W (2006)**[44] tested the hypothesis that mechanical forces combined with low-level laser therapy stimulate the rate of orthodontic tooth movement. 12 young adult patients who required retraction of maxillary canines into first premolar extraction spaces using tension coil springs with fixed edgewise appliance was taken into the study. Low level laser was applied on the mucosa buccally, distally and palatally to the canine on the test side and using a pseudo-application on the placebo side. Dental impressions and casts were made at the commencement of the trial and at the end of the first, second and third months after starting the trial. Measurement of tooth movements was made on each stage model using a stereo microscope. The results showed that there was no significant difference of means of the canine distal movement between the low level laser therapy side and the placebo side for any time periods. The energy density of low level laser therapy (GaAlAs) at the surface level in this study

(25J/cm(2)) was probably too low to express either stimulatory effect or inhibitory effect on the rate of orthodontic tooth movement.

**Cruz DR (2004)**[16] studied the effects of low-intensity laser therapy on the orthodontic movement velocity of human teeth. Eleven patients were recruited for this 2-month study. One half of the upper arch was considered control group (CG) and received mechanical activation of the canine teeth every 30 days. The opposite half received the same mechanical activation and was also irradiated with a diode laser emitting light at 780 nm, during 10 seconds at 20 mW, 5 J/cm$^2$, on 4 days of each month. All patients showed significant higher acceleration of the retraction of canines on the side treated with low intensity laser therapy when compared to the control.

**Sousa MV (2011)**[76] evaluated the effect of low level laser irradiation on the speed of orthodontic tooth movement of canines submitted to initial retraction. 26 canines were retracted using NiTi springs (force of 150gms/side). Thirteen of those were irradiated with diode laser (780nm, 20mW, 10sec, 5J/cm(2)) for 3 days, and the other 13 were not irradiated and thus were considered the control group. Patients were followed up for 4 months, and nine laser applications were performed (three each month). A statistically significant increase in the movement speed of irradiated canines was observed in comparison with non-irradiated canines in all evaluation periods. The study concluded that the diode laser used within the protocol guidelines increased the speed of tooth movement and that this might reduce orthodontic treatment time.

**Kim DH (2008)**[88] determined whether an exogenous electric current to the alveolar bone surrounding a tooth being orthodontically treated can enhance tooth movement in human and to verify the effect of electric currents on tooth movement in a clinical aspect. This study was performed on 7 female orthodontic patients. The electric appliance was set in the maxilla to provide a direct electric current of 20 micronA. The maxillary canine on one side was assigned as the experimental side, and the other as control. The experimental canine was provided with orthodontic force and electric current. The control side was given orthodontic force only. Electrical current was applied to experimental canines for 5 hours a day. The result of the amount of orthodontic tooth movement in the experimental side during 4 weeks was greater by 30% compared to that of the control side. These results suggested that the exogenous electric current from the miniature electric device might accelerate orthodontic tooth movement by one third and have the potential to reduce orthodontic treatment duration.

**Showkatbakhsh R (2010)**[54] designed a study to determine whether a pulsed electromagnetic field (PEMF) affects orthodontic tooth movement. The canines of one side of 10 patients (mean age 23.0 ± 3.3 years) who needed canine retraction were exposed to a PEMF; the canines on the contralateral sides of the same patients were not similarly exposed. After extraction of the maxillary first premolars, both canines were retracted with coil springs. A circuit and a watch battery were used to generate a PEMF (1 Hz). The generator was embedded in a removable appliance. Foil was used to obstruct the control group from PEMF exposure. Patients were instructed to use the device from the commencement of canine retraction, and it was removed when Class I canine relationship was achieved in either of the canines after 5.0 ± 0.6 months. The results with exposure to a PEMF, canine retraction was 1.57 ± 0.83 mm more than the control group and suggested that application of a PEMF can accelerate orthodontic tooth movement.

**Acceleration of tooth movement by surgical means:-**

**Rudolf Hasler (1997)**[28] studied the rate of movement of the maxillary canines into the healed or recent extraction alveolus of the first premolar was measured in 22 patients of 10-27 years. On one side of the dental arch, the first premolar was extracted. After a median time of 86 days, the contralateral first premolar was extracted and the distalization of both canines started using Gjessing canine retraction springs. The canine on the recent extraction side moved faster than that on the healed side, but with some amount of tipping.

**Liou EJ (1998)**[45] conducted an invivo studies using fifteen orthodontic patients (26 canines, including 15 uppers and 11 lowers) who needed canine retraction and first premolar extraction. At the time of first premolar extraction, the interseptal bone distal to the canine was undermined with a bone bur, grooving vertically inside the extraction socket along the buccal and lingual sides and extending obliquely toward the socket base. Then, a tooth-borne, custom-made, intraoral distraction device was placed to distract the canine distally into the extraction space. It was activated 0.5 to 1.0 mm/day immediately after the extraction. Both the upper and lower canines were distracted bodily 6.5 mm into the extraction space within 3 weeks. New alveolar bone was generated and remodeled rapidly in the mesial periodontal ligament of the canine during and after the distraction. It became mature and indistinguishable from the native alveolar bone 3 months after distraction. During the distraction, 73% of the first molars did not move mesially and 27% of them moved less than 0.5 mm mesially within 3 weeks. The study concluded that the periodontal ligament could be rapidly distracted without complications. The rapid orthodontic tooth movement through distracting the periodontal ligament cannot be emulated by current conventional orthodontic concepts and methods.

**Yadav Sumit (2005)**[45] reviewed canine distraction by corticotomy along with conventional orthodontic therapy with the help of customized distraction device. The overall treatment time was reduced by almost 5 months without any complications. The distraction device however proved to be bulky and caused discomfort to the patient.

**Iseri et al (2005)**[31] through “distraction osteogenesis.” Their study consisted of 20 maxillary canines in 10 growing or adult subjects. First premolars were extracted and the canines were subjected to retraction therapy in a surgical site using a customized, rigid, tooth-borne retraction device. They moved the cuspids about 0.8 mm per day. The full retraction of the canines was achieved in a mean time of 10 + 2 days.

**Kharkar VR etal (2010)**[36] **compared** using two different surgical techniques: dento-alveolar distraction and periodontal distraction to bring about rapid canine retraction using an indigenously designed intra-oral distractor, Six patients, comprising two groups, were compared. The patients were assessed at regular intervals with intra-oral periapical radiographs and lateral cephalograms for gauging the time required for retraction, canine tipping, anchorage loss and external root resorption. The result suggested that Dento-alveolar distraction was superior to periodontal distraction in all areas of assessment.

**Hu Long (2012)**[46] evaluated the effectiveness of interventions on accelerating orthodontic tooth Movement (systematic review) for which databases of PubMed, Embase, Science Citation Index, CENTRAL, and SIGLE from January 1990 to August 2011 were searched that assessed the effectiveness of interventions on accelerating orthodontic tooth movement. Assesed interventions (low-level laser therapy, corticotomy, electrical current,pulsed electromagnetic fields, and dentoalveolar or periodontal distraction).

The systematic review revealed that:

a. Corticotomy is effective and safe procedure to accelerate orthodontic tooth movement.
b. Low-level laser therapy was ineffective to accelerate orthodontic tooth movement.
c. Current evidence does not reveal whether electrical current and pulsed electromagnetic fields are effective in accelerating orthodontic tooth movement.
d. Dentoalveolar or periodontal distraction is promising in accelerating orthodontic tooth movement but lacks convincing evidence.

## 3. Corticotomy Assisted Orthodontics

**Newman WG (1955)**[59] quoted that adults, compared with young patients, possess characteristics such as reduced spongeous bone, an increase in cortical bone density, a decrease in bone volume, and apical displacement of the marginal bone level, which limit the usefulness of conventional orthodontic treatment. As a result, such problems as marginal bone loss, root exposure, root resorption, and prolonged treatment time often occur in cases involving adults.

**Handelman CS (1996)**[7] described the characteristics of the anterior alveolar bone have an adverse impact on efforts to remodel bone, particularly in adult bimaxillary protrusion cases that display incompetence in lip repose. The anatomic limits set by the cortical plates of the alveolus at the level of the incisor apices act as orthodontic walls. Post treatment results show less remodeling than desired, and severe resorption has occurred when conventional orthodontic treatment was performed alone.

**Cunningham (1893)**[12] first proposed the Surgically Facilitated Orthodontic Therapy (SFOT) which is a 100 year-old idea that has evoked a progression of surgical refinements designed to (a) accelerate orthodontic tooth movement, (b) limit the quantity and pathologic potential of the inevitable bacterial load, (c) enhance stability, and (d) reduce the morbidity of orthognathic alternatives.

**Frost HM(1981)**[22] found a direct correlation between the severity of bone corticotomy and/or osteotomy and the intensity of the healing response, leading to accelerated bone turnover at the surgical site. This was designated “Regional Acceleratory Phenomenon” (RAP). RAP was explained as a temporary stage of localized soft and hard-tissue remodeling that resulted in rebuilding of the injured sites to a normal state through recruitment of osteoclasts and osteoblasts via local intercellular mediator mechanisms involving precursors supporting cells, blood capillaries and lymph

**Cohn-Stock (1921)**[11] citing “Angle’s method,” removed the palatal bone near the maxillary teeth to facilitate retrusion of single or multiple teeth.

**Skinner (2000)**[79] stated that just before World War II, Bichlmayr described a corticotomy for patients older than 16 years, to accelerate tooth movement and reduce relapse for maxillary protrusion. This was employed with canine retraction after first bicuspid extraction, by excising the buccal and lingual cortical plates at the extraction site.

**Skinner (2008)**[78] mentioned in his publication that Skogborg[49] in 1926 divided the interdental bone, with a procedure he called "septotomy," and later Ascher[47] published a similar procedure, claiming that it reduced treatment duration by 20-25%. These procedures were combined with Bichlmayr's procedure by Neuman[48] He divided the inter-radicular bone and ablated a wedge of bone palatal to the incisors meant to be retracted.

**Kretz(1947)**[12] described a procedure similar to Cunningham's, creating, in effect, a therapeutic fracture of the anterior alveolus. His aggressive manipulation of bone contrasts sharply with modern selective alveolar decortication, a more conservative decortication designed for a proportionate response and a method which proscribes against any aggressive bone manipulation that might compromise vasculature.

**Heinrich Kole(1959)**[38] brought about decortication of the dentoalveolar process to facilitate OTM. With some notable refinements, this is the basic technique that is employed today by those who promote the integration of orthodontic therapy and periodontal surgery. The surgery was limited to the cortex of the dental alveolus, but subapical decortication was embellished by extending buccal and lingual cortical plate incisions until they communicated through the subapical spongiosa. Gross movements with heavy orthodontic forces with active tooth movement was achieved within 6 to 12 weeks and a period of 6 to 8 months of retention offered remarkable stability.

**Bell and Levy in (1972)**[4] studied "corticotomy" techniques in Macaca mulatta, with a lack of specific details combined with disparaging, but undocumented observations. They noted that it "had a destructive effect on maxillary incisors "but failed to elaborate specifically. The operated tooth-bone segments were also luxated with a chisel, a procedure which even they admit may have been a more proximate cause of the ischemia.

**Merrill and Pedersen (1976)**[52] claimed that selective alveolar decortications (SAD) limited to the labial alveolar cortex is a reasonable variant where the surgeon may wish to facilitate simple labial movement and wants to maintain a copious blood supply form the lingual aspect and reflection of lingual mucoperiosteal flaps for labial movement may also contribute to greater stability by producing a more dissipated therapeutic osteopenia.

**Generson and Porter (1978)**[23] applied the decortication concept to the treatment of anterior open bites. They departed from aggressive osteotomies and segment mobilization explicitly, stating that "…the surgery was done from both the labial and lingual approaches... the bony cuts are made though the cortex …marrow was able to maintain viability of the osseous segments. " They cite stability and speed as advantages to their technique, and emphasized full thickness (mucoperiosteal) flaps, resecting the neurovascular bundle of the incisive canal. They initiated orthodontic force 3 days after surgery.

**Mostafa et al(1985)**[55] diagrammed a surgical-orthodontic technique to treat over-erupted maxillary molars. It was a procedure similar to decortication localized to the alveolus of one tooth as advocated by Kole. They reported a survey of 15 patients, noting that only the cortex was incised with a surgical bur and osteotome. No indication was made if the surgery was done on the palatal aspect as well as the diagrammed buccal procedure. Further, no statistical analysis or even photographs were presented.

**Goldson and Reck (1987)**[25] reported a similar surgical-orthodontic treatment of malpositioned cuspids just two years later. They reported on the use of a bur and osteotome, combination to completely separate the dentoalveolar segment through both the buccal cortex and medullary bone.

**Suya (1991)**[83] revived with “corticotomy-facilitated orthodontics” by reporting his experiences in over 300 patients. He did not connect the buccal and labial incisions, like Kole, but relied on linear interproximal decortication. The style of decortication, divots, lines or other patterns is irrelevant. Only the sum total of therapeutic trauma is significant. It should be noted that the particular pattern of decortication, for example, divots, lines pints or other patterns, is irrelevant. Only the sum total of all therapeutic “trauma” (stimuli) is significant in its inducement of osteopenia. Suya’s refinement of Kole’s methods has essentially set the standard for decortication procedures that followed in the Modern era.

**Wilcko (2001)**[94] demonstrated two case reports (24-year-old man with a Class I severely crowded malocclusion and an overly constricted maxilla with concomitant posterior crossbites and a 17-year-old female with a Class I moderately to severely crowded malocclusion). Surgical technique included buccal and lingual full-thickness flaps, selective partial decortication of the cortical plates, concomitant bone grafting/augmentation, and primary flap closure. From bracketing to debracketing, both cases were completed in approximately 6 months and 2 weeks. The canine and premolars in this area were expanded buccally by more than 3 mm and an increase in the buccolingual thickness of the overlying buccal bone. Additionally, a preexisting bony fenestration buccal of the root of the first premolar was covered. Both of these findings lend credence to the incorporation of the bone augmentation procedure into the corticotomy surgery because this made it possible to complete the orthodontic treatment with a more intact periodontium.

**Hajji SS (2001)**[27] investigated the efficacy of a technique combining orthodontic with alveolar corticotomy + grafting as an effective treatment for Class I and II malocclusions in comparison with conventional, non-surgical orthodontic non-extraction and extraction therapies. He found that there were no differences between the RAP or AOO procedure and traditional nonextraction treatments, except that treatment was three to four times faster in the corticotomyassisted group and B point increased significantly due to the alveolar augmentation.

**Hwang (2001)**[29] used repelling magnets to apply the orthodontic force after corticotomy to intrude over-erupted molar. He also proposed that heavier force is needed than in conventional orthodontic tooth movement, and more frequent reactivation is recommended—movement will be delayed and the alveolar bone may heal prematurely if force adjustments are done at the same intervals as conventional orthodontics.

**Machado et al (2002)**[50] compared root resorption of the upper central incisors following non-extraction orthodontic treatment with and without alveolar corticotomy surgery. Treatment duration with corticotomy therapy (6.3 months) and without corticotomy was (25.9 months). In this study, corticotomy facilitated non-extraction orthodontic therapy resulted in half as much resorption at debanding and at long term retention than in conventional non-extraction orthodontics at debanding.

**Chung KR (2003)**[41] reported a decortication-assisted orthodontic method for posterior intrusion and anterior retraction. The procedure combined with conventional orthodontic mechanics avoided undesirable side effects without the need for orthognathic surgery, thus enhancing the stability of results and shortened the treatment time.

**Shoichiro Iino (2006)**[74] published case report of adult bimaxillary protrusion treated with Corticotomy-Facilitated orthodontics and titanium miniplates. The maxillary first premolars and mandibular second premolars were extracte,.at the same time, a corticotomy was performed on the cortical bone of the lingual and buccal sides in the maxillary anterior as well as the mandibular anterior and posterior regions. Leveling was initiated immediately after the corticotomy. The extraction spaces were closed with conventional orthodontic force (approx. 1 N per side). The edgewise appliance was adjusted once every 2 weeks. The total treatment time was 1 year.

**Raffaele Spena (2006)**[62] used Segmental Corticotomy to Enhance Molar Distalization. Decortication was then performed with a round bur on a high-speed handpiece (20,000rpm) under normal saline irrigation. Vertical incisions were made between the roots of the first and second molars and connected by horizontal cuts beyond the apices, ending 1-2mm below the alveolar crests. Several holes were then drilled, both buccally and palatally, to create a bleeding bed for the graft. One week after surgery, molar distalization was initiated by placing 200g nickel titanium coil springs on the maxillary archwire between the second premolars and first molars. The corticotomies reduced molar resistance to distal movement and eliminated the need for anterior anchorage.

**Fischer TJ (2007)**[25] evaluated six consecutive patients presenting with bilaterally impacted canines were compared. One canine was surgically exposed using a conventional surgical technique while the contra lateral canine was exposed using a corticotomy-assisted technique. Both the methods revealed a reduction of treatment time of 28–33% for the corticotomy-assisted canines. No significant differences were observed in final periodontal condition between the canines exposed by these two methods.

**Thomas Wilcko (2008)**[49] named the new interpretation of the rapid movement as “bone matrix transportation” has made it possible to design a surgical approach, which permits extraction space closure in 3 to 4 weeks. This protocol allows conventional OTM 300% to 400% faster, increases the envelope of movement 2- to 3-fold and alveolar augmentation (periodontally accelerated osteogenic orthodontics or PAOO), and increases alveolar volume providing an alternative to bicuspid extraction. He emphasized that "Mobilization" of any outlined single-tooth blocks of bone (luxation) is absolutely contraindicated and can lead to intrapulpal and intraosseous morbidity and will not increase the distance that the tooth can be moved.

**Sebaoun (2008)**[33] investigated the alveolar response to corticotomy as a function of time and proximity to the surgical injury in rats. Maxillary buccal and lingual cortical plates were injured in 36 healthy adult rats adjacent to the upper left first molars. Euthanized animals were subjected to histomorphometric analysis was performed to study alveolar spongiosa and periodontal ligament. At 3 weeks, the surgery group had significantly less calcified spongiosa bone surface, greater periodontal ligament surface, higher osteoclast number, and greater lamina dura apposition width. The catabolic activity (osteoclast count) and anabolic activity (apposition rate) were three-fold greater, calcified spongiosa decreased by two-fold, and PDL surface increased by two-fold. Surgical injury to the alveolus that induced a significant increase in tissue turnover by week 3 dissipated to a steady state by postoperative week 11. The impact of the injury was localized to the area immediately adjacent to the decortication injury.

**Kim (2009)**[82] developed an interesting technique that is often contrasted with flap reflection methods. Although it does not allow the surgeon to visualize periodontal pathosis, and may indeed exacerbate pre-existing lesions, they successfully used a method of transmucosal incision "corticision," wherein a reinforced scalpel is used as a thin chisel to separate the interproximal cortices trans-mucosally, without a surgical flap reflection.

**Thomas Wilcko (2009)**[48] again proposed a1-stage surgically facilitated rapid orthodontic technique with alveolar augmentation were the orthodontic brackets are placed and a light wire engaged sometime during the week before the surgery with the subsequent orthodontic adjustments being made at 2-week intervals. A full case in which upper and lower arches are treated surgically can require 3 to 4 hours to complete usually was performed under intravenous or oral sedation. The adviced grafting material be 100% demineralized freezedried bone allograft (DFDBA), a mixture of DFDBA and bovine bone, or a mixture of DFDBA and mineralized freeze-dried bone allograft. The movement of the teeth in the AOO treatment was accomplished through tipping and then uprighting.

**Payam A. Sanjideh (2010)**[60] carried out a split-mouth experimental study to determine tooth movements in foxhounds after one or two alveolar corticotomies. He found that the rates of maxillary tooth movement slowed over time, with significantly more overall tooth movement on the side that had two (2.3 mm) than one (2.0 mm) corticotomy procedure. He concluded that performing a second corticotomy procedure after 4 weeks maintained higher rates of tooth movement over a longer duration and produced greater overall tooth movement than performing just one initial corticotomy, but the difference was small.

**Ali H Hassan (2010)**[1] introduced a new technique for treating unilateral posterior crossbite in adults. Corticotomy was performed both on buccal and palatal to the around the molar in cross biteand the inter-molar distance was increased by 3 mm to 4 mm. He proposed that the use of simple expanders, such as heavy labial wires, combined with regular fixed orthodontic appliances instead of the conventional bulky palatal expanders.

**Aboul-Ela et al (2011)**[73] evaluated miniscrew implant-supported maxillary canine retraction with corticotomy-facilitated orthodontics.The invivo study used miniscrews as anchorage, canine retraction was initiated via closed nickel-titanium coil springs applying 150 g of force per side. He found that the average daily rate of canine retraction was significantly higher on the corticotomy than the control side by 2 times during the first 2 months after the corticotomy surgery. This rate of tooth movement declined to only 1.6 times higher in the third month and 1.06 times higher by the end of the fourth month. No molar anchorage loss occurred during canine retraction on either the operated or the nonoperated side. There was no statistically significant difference between preoperative and postoperative measurements of plaque index, probing depth, attachment loss, and gingival recession.

**Hwang et al (2011)**[20] described the case of a 13-year-old boy with anterior open bite complicated by an ankylosed maxillary central incisor that was treated by individual corticotomy and subsequent orthodontic traction. Individual corticotomy of the ankylosed maxillary right central incisor was performed twice, ankylosed tooth extruded after two weeks. Thus individual corticotomy and miniscrew application for posterior intrusion enhanced the efficiency of treatment for open bite and tooth ankylosis

**Baloul et al (2011)**[68] used a total of 114 Sprague-Dawley rats were included in 3 treatment groups: selective alveolar decortication alone; tooth movement alone; and combined therapy. Microcomputed tomography. RNA markers of osteoclastic cells and key osteoclastic regulators (M-CSF [macrophage colonystimulating factor], RANKL [receptor activator of nuclear factor kappa-B ligand], OPG [osteoprotegerin], calcitonin receptor [CTR], TRACP-5b [tartrate-resistant acid phosphatase 5b], cathepsin K [Ctsk]) all showed expression indicating increased osteoclastogenesis in the combined group. RNA markers of osteoblastic cells (OPN [osteopontin], BSP [bone sialoprotein], OCN [osteocalcin]) also showed increased anabolic activity in response to the combination of alveolar decortication and tooth movement. The study provided the first scientific evidence for the role of coupled osteoclastic and osteoblastic activity in response to alveolar decortication through which the orthodontic tooth movement is enhanced.

**Neal C Murphy (2006)**[58] stated that demineralized bone matrix may be used to augment "basal bone" when fenestration or dehiscence are noted upon flap reflection or when orthodontist needs a larger bony base to avoid extraction of healthy bicuspid teeth.Otherwise it is not necessary where labial bone is surfeit. He quoted that augmentation of the alveolus is impossible where grafting is done without the field of orthodontic tensional stress and proposed that it is a genetic manipulation (gene therapy). He added that actual dose of the graft and subperiosteal scarification cannot be standardized for every procedure, because degree of optimal response depends on type of surgery, dosage and natural biologic diversity of individual patient's bone physiology. Osteopenia is necessary only within 2-3 mm of the teeth to be moved. Keeping many other areas of the dentition un-operated with SAD provides a relative anchorage module.

**Jin- Kyung Lee(2007)**[71] compared the treatment outcomes of orthodontic treatment, anterior segmental osteotomy and corticotomy assisted orthodontic treatment for resolution of bimaxillary dentoalveolar protrusion. 65 Korean adult female were divided as: group 1 (orthodontic treatment), group 2 (corticotomy-assisted orthodontic treatment with skeletal anchorage in the maxilla and anterior segmental osteotomy in the mandible), group 3 (anterior segmental osteotomy in the maxilla and mandible). He derived his findings as: Orthodontic treatment or corticotomy-assisted orthodontic treatment is indicated for those with severe incisor proclination with normal basal bone position, (although advantageous for adult patients concerned with treatment duration.) and Anterior segmental osteotomy is recommended for bimaxillary dentoalveolar protrusion patients with a gummy smile, basal bone prognathism, relatively normal incisor inclination, and relatively underdeveloped chin position.

**Lee JK (2007)**[80] on emphasizing about the contraindication of corticotomy assisted orthodontics proposed that patients with active periodontal disease or gingival recession are not good candidates for CAOT. In addition, CAOT should not be considered as an alternative for surgically assisted palatal expansion in the treatment of severe posterior cross-bite. CAOT also should not be used in cases where bimaxillary protrusion is accompanied with a gummy smile, which might benefit more from segmental osteotomy.

**Neal C Murphy (2012)**[57] conceptualized that intermittent and random stimuli (adjustments every 1–2 weeks) keep the bone osteopenic. The best tool is a kind of transmucosal penetration (TMP) into the alveolus as an intentional, controlled and therapeutic wounding**.** accomplished by making these punctuate penetrations/perturbations directly through the alveolus without flap reflection). The technique employs a high speed surgical length #2 round bur with external irrigation. TMP is an attempt to reinvigorate the tissue healing dynamics, after the regional osteopenia (or RAP) has extinguished. The mechanically induced RAP, usually lasting only 6–9 months therefore this procedure is sometimes needed to reassert the induced osteopenic state without resorting to a second surgery.

**Richard D Roblee (2009)**[64] based on considerations for timing of corticotomy suggested that: If the discrepancies are primarily dentoalveolar (severe crowding with alveolar bone deficiency), corticotomy is performed within two weeks of orthodontic appliance placement thus minimizing tooth movement along a deficient alveolus. When the underlying problem is alveoloskeletal (dentoalveolar retrusion or protrusion) the osteotomy should be performed after orthodontic leveling and aligning has been completed which allows use of rigid archwires to better control the segments.

# MATERIALS AND METHODS

- **Patient selection and preparation**
- **Criteria for sample selection**
- **Patient records**
- **Armamentarium**
- **Method**
- **Radiograph evaluation**
- **Statistical evaluation**

## Patient selection and preparation

Patients who reported to the Department of Orthodontics at Ragas Dental College and Hospital, Chennai, India, between January and June 2012 were screened for the study. 20 adult patients with bimaxillary protrusion for correcting the bidental proclination were selected for the study. Among those, 7 patients who were willing to undergoe surgery to speeden their orthodontic treatment were selected as sample for the study and 7 patients who were reluctant to undergo any surgical interventions but were desired for conventional orthodontic treatment constituted the control group.

**Criteria for sample selection**

Inclusion criteria:

1. Cases with Bimaxillary protrusion:
    a. -Angles Class I malocclusion.
    b. -Interincisal angle <125°.
    c. -Crowding ≤3mm.
2. Requiring first premolar extraction in all the four quadrants to establish normal axial inclination of the anteriors.
3. No symptoms of temperomandibular disorders.
4. Adult patients between the age of 18-25yrs.
5. Patients with satisfactory periodontal health, good bone support, adequate attached gingival.
6. Patients with good oral hygiene.
7. Not under any systemic medication.

Exclusion criteria:

1. Patients with severe skeletal dysplasia in transverse, vertical and sagittal direction
2. Patients with poor periodontal health.
3. Non consenting adults.
4. Patients with severe crowding.
5. Patients on medication for systemic disorders, pregnancy or steroid therapy.

The study protocol was approved by the Institutional Review Board of Ragas Dental College and Hospital institutional research ethics committee. The ethical consideration in this study was of intentionally creating corticotomy cuts and placing allogenic graft in these patients. (Annexure)

**Patient records:**

After the cases were screened and found suitable, written informed consent was obtained. Routine orthodontic records including case history, pre treatment study models, extraoral and intraoral photographs, lateral cephalograms and orthopantamograms were acquired before the start of the treatment, before the start of retraction and after completion of retraction.

**Armamentarium: (**Fig.I : Armamentarium)

- ❖ MiniOvation Roth bracket prescription 0.22’ slot (Dentsply GAC) (fig.I: a)
- ❖ Closed Niti coil spring (RMO) (fig.I: b)
- ❖ Stainless steel ligature (fig.I: d)
- ❖ Dontrix gauge (fig.I: e)
- ❖ Vernier caliper (fig.I: f)

Surgical armamentarium: (Fig.II : Armamentarium)

- ❖ #701 fissure bur (fig.II: b)
- ❖ DFDBA- Rocky mountain graft (fig.II: e)
- ❖ Vicryl 4-0 suture (fig.II: d)
- ❖ B.P blade No.15 (fig.II: c)

Figure I: ARMAMENTARIUM

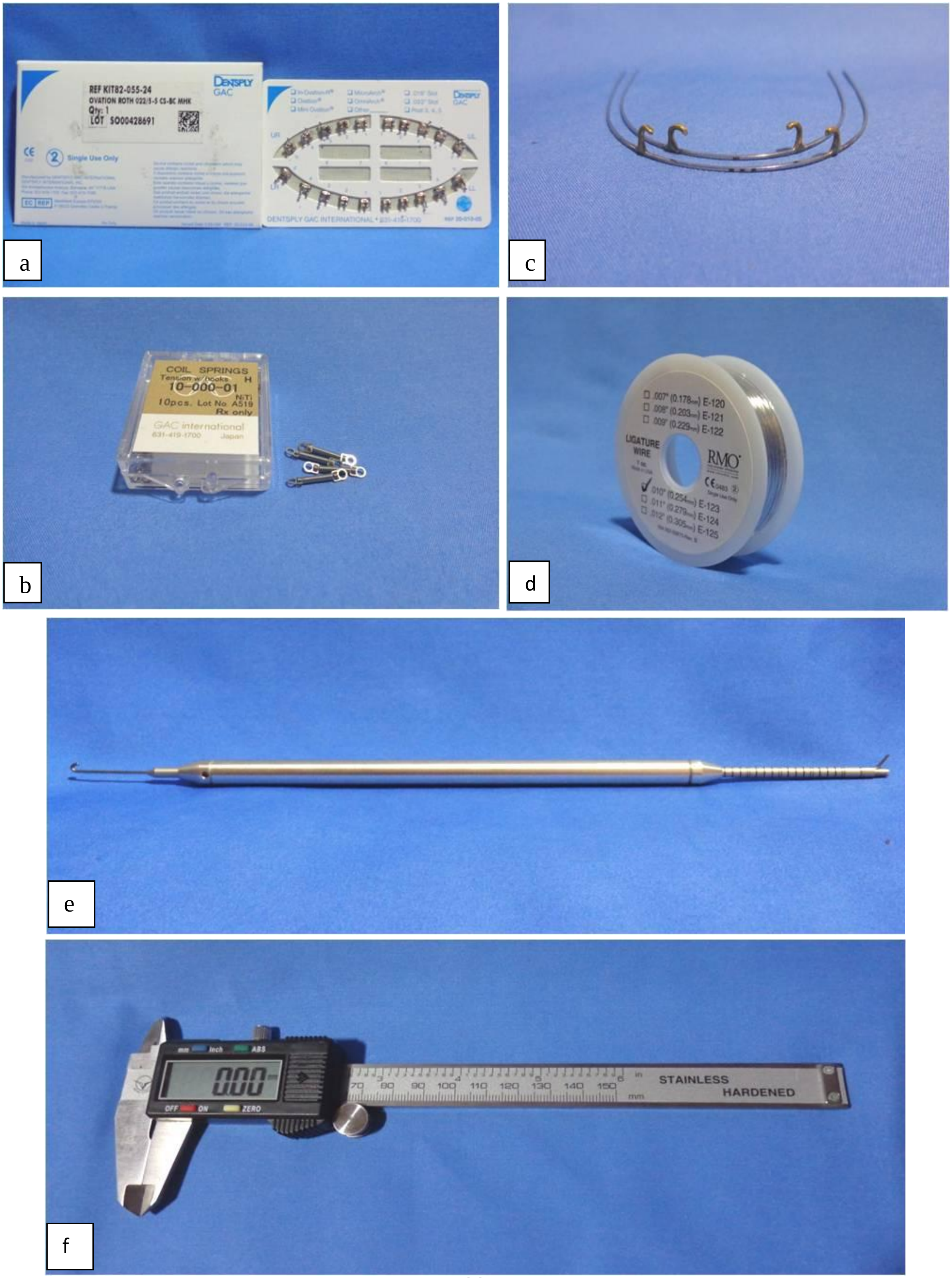
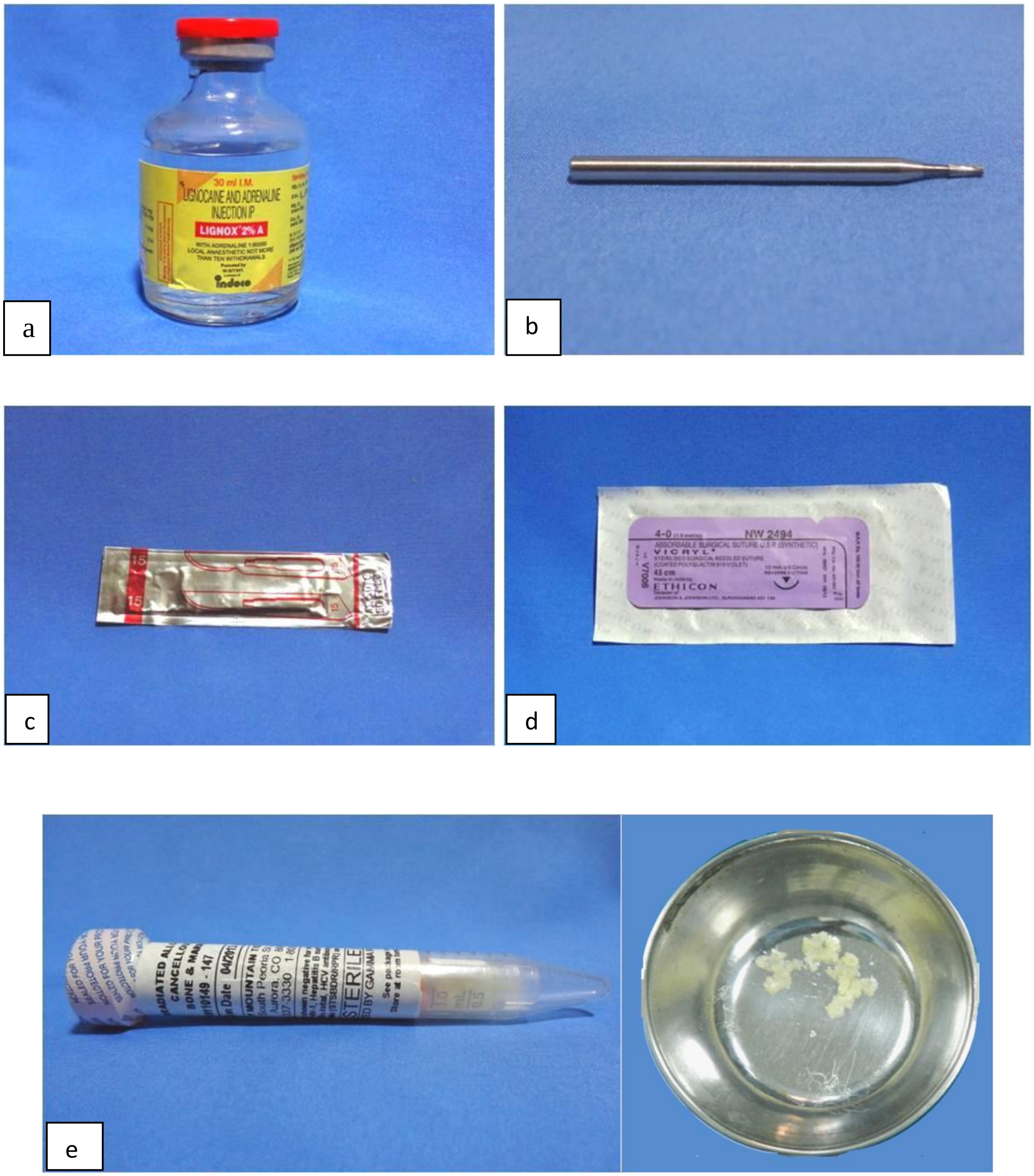


Figure II: ARMAMENTARIUM



**Method:**

All patients included in the study required extraction of all first premolars and were treated with 0.022' slot Roth appliance. In the study group the leveling and aligning was carried out until 0.019"X 0.025" stainless steel archwire could be fully engaged in the bracket slot, the first premolars were not-extracted till the time the retraction stage in the treatment was commenced (fig III: a). Whereas in the control group the first premolars were extracted prior to aligning stage of aligning (fig. IV: a) as it was the conventional method. Brackets were not bonded in the study group if the first premolars were fairly well aligned. Stainless steel 0.019"X 0.025" working wires with soldered brass hooks between the lateral incisor and the canine for anterior retraction, was used in this study (fig.I: c).

The surgery was carried out under local anesthesia(Lignox 2%A) (figII: a). Surgical procedure was handled by the same Maxillofacial surgeon throught the study. Lower arch procedure was always executed 2 weeks ahead of the upper arch (fig.III: b,c,h). First premolars were extracted at the time of the surgery and the stainless steel 0.019"X 0.025" archwire with soldered brass hooks was palced before flap elevation in the experimental group. Sulcular incisions using B.P blade no.15 were placed from distal aspect of one canine to the contra lateral canine and a full thickness flap was elevated involving the anteriors, 3mm above the apical region of the tooth to expose the underlying cortical bone.

701 fissure bur and no.2 size round bur mounted on a micromotor handpiece under copious amount of irrigation was used for selective alveolar decortication. If there was a good amount of inter-root distance between two adjacent teeth vertical interdental scoring was done otherwise only punch hole perforations were placed in the area available, stopping 2mm short of the alveolar crest, occlusaly. The vertical decortication was connected by the horizontal

decortications 2mm beyond the root apex. Selective alveolar decortication from the mesial aspect of one canine to the mesial surface of the contralateral canine involving the anteriors was performed. Similarly a careful palatal flap incision was raised for decortications of the palatal bone (figIII: b,c,d,e). The cuts extend only into the superficial aspect of the medullary bone to just enhance bleeding for the RAP to occur.

The graft material used in the study was particulate demineralized freeze dried bone allograft (DFDBA-Rocky mountain tissue bank) (figII: e) wetted with sterile saline solution to facilitate ease of placement. The quantum of bone grafting was dependent upon the pre-existing bone, about 0.5-1cc of graft material was required per arch over the decorticated area. Grafting was done when the quality and quantity of the bone was questionable alone.[57] Particulate grafting material was maintained in the desired position by performing the full thickness flap that was coronally advanced to cover the grafting material, they were sutured with an interrupted loop, non resorbable 4-0 black silk suture material. The sutures were left in place for 1-2weeks.

Initiation of orthodontic force was done within 5-7 days after the surgery with the help of closed Niti coil spring which was engaged from the first molar tube to the soldered hook on the archwire delivering a force of 250gms for en-masse retraction using sliding mechanics (fig.III: h,i). In the control group a similar archwire delivering the same amount of force without the surgical procedure was used for retracting the anteriors (fig.IV: a,b). Retraction was checked every 2 weeks for distortion of the coil spring and immediately replaced if distorted.

Figure III: METHODOLOGY- STUDY GROUP

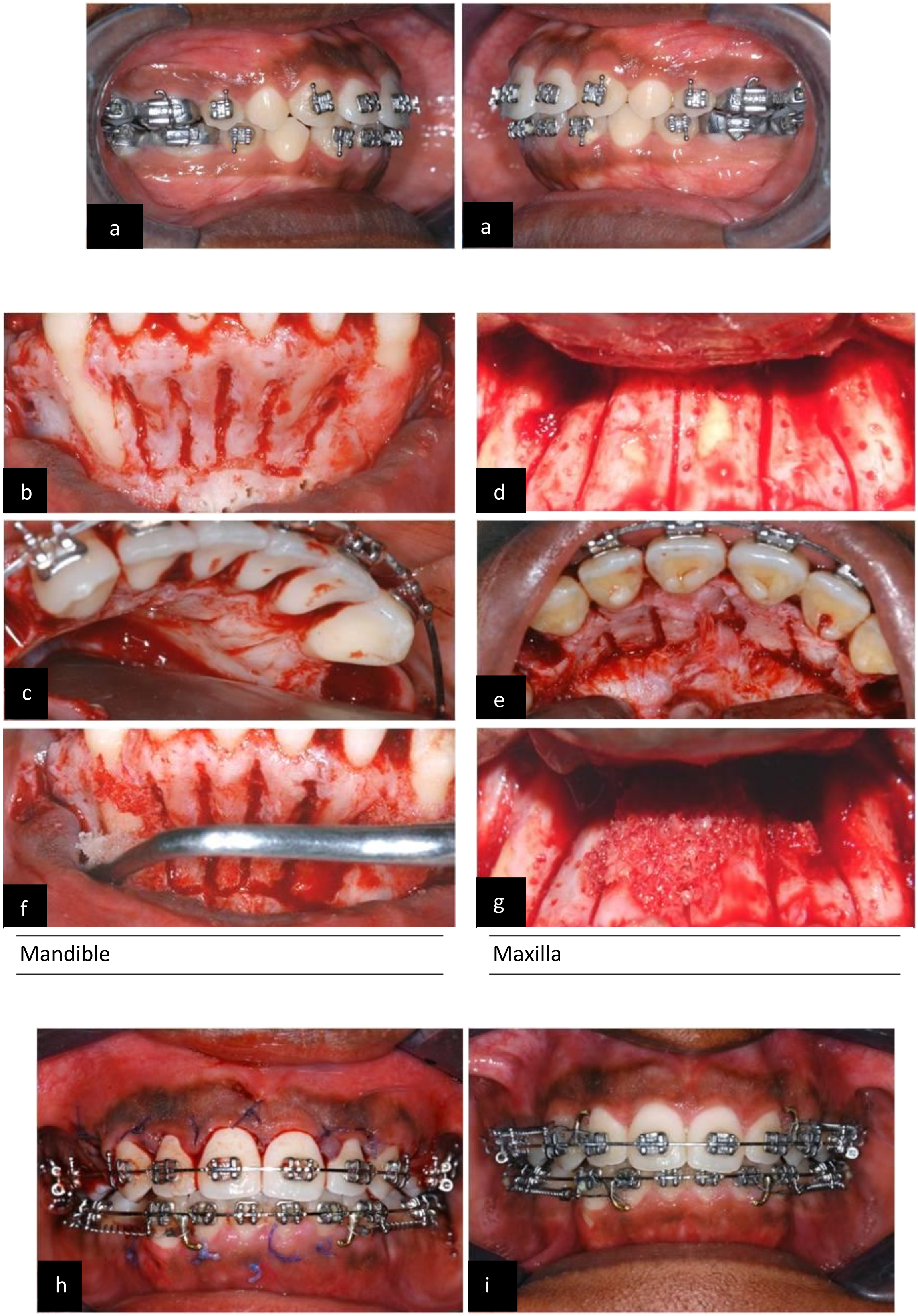


Figure IV: METHODOLOGY- CONTROL

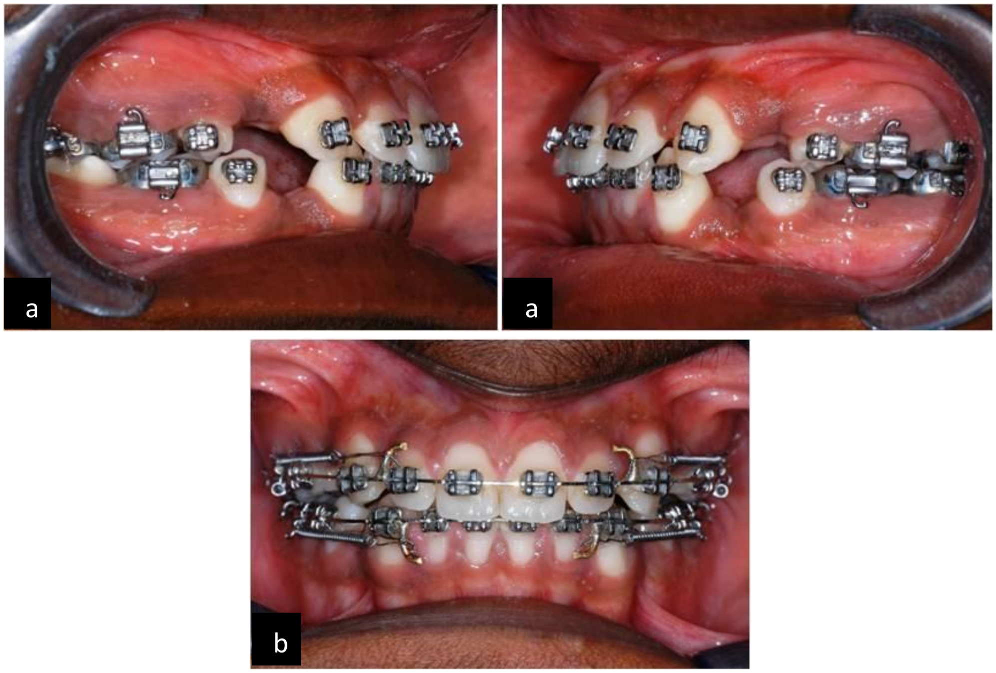
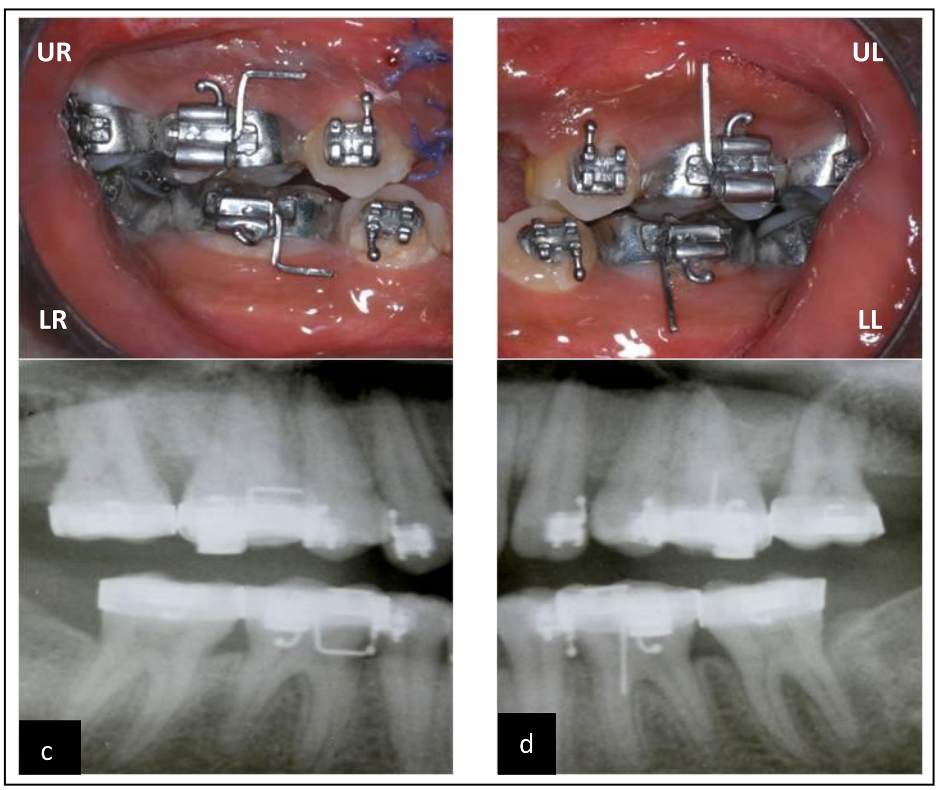



Figure V: Reference jigs



Initial measurements were done after extraction using a vernier caliper from the maximum contour of the the mesial point of second premolar to the distal maximum contour of the canine. Lateral cephalogram and orthopantamograms were taken with standardization jig placed on the upper and lower first molars before retraction (fig IV: c,d). Study models were taken at monthly intervals and the radiographic records were taken every 2 month to assess the treatment time, period of accelerated tooth movement, anchorage control, soft and hard tissue changes. The period of study ranged from 4 to 6 months.

Thus the efficacy, efficiency and viability of this new method of retraction with and without corticotomy were evaluated.

**Cephalometric variables used for case selection of the study:**

Profile cephalograms were taken in occlusion under standardized conditions with a cephalostat and tracing were done. Pre and post retraction were carefully traced for each patient on (8X10 inch) acetate paper. All cepahalograms were manually traced by a single investigator and checked twice. (figure VI: a,b)

**Cepahalometric landmarks:**[32,63] used in this study (fig.VI: a)

1.Sella (S) : Geometric center of the pituitary fossa located by visual inspection.

2.Nasion (N) : The most anterior point on the frontonasal suture in the midsagittal plane.

3.Porion (Po) : The most superiorly positioned point on external auditory meatus

4.Orbitale (Or) : The lowest point on the inferior rim of the orbit.

5.Basion (Ba) : The lowest point on the anterior rim of foramen magnum.

6.Posterior nasal spine (PNS) : Posterior spine of the palatine bone constituting the hard palate.

7.Anterior nasal spine (ANS) : Anterior tip of the sharp bony process of the maxilla at the lower margin of anterior nasal opening.

8.Pogonion (Pg) : The most anterior point on the chin.

9.Menton (Me) : The lowest point on the symphyseal shadow of the mandible seen on the lateral cephalogram.

10.Gonion (Go) : A point on the curvature of the of the angle of the mandible locating by bisecting the angles formed by lines tangent to the posterior ramus and the inferior border of the mandible.

11.Gnathion (Gn) : A point located by taking the midpoint between the anterior (Pg) And inferior (Me) points of bony chin.

12.Pt point (Pt) : The outline of the foramen rotundum can be located by using the template designed for that purpose or it can be approximated at the 10.30 (face of a clock) position on the circular outline of the superior border of the pterygomaxillary fissure.

13.Point (A) : The most posterior midline point in the concavity between the anterior nasal spine and the prosthion (the most inferior point on the alveolar bone overlying the maxillary incisors).

14 U1 E : Incisal tip of maxillary central incisor.

15. U1 A : Upper incisor root apex.

16.U6 D : Most distal point of mesial surface of maxillary first molar crown.

17.Point (B) : The point at the deepest midline concavity on the mandibular symphysis between infradentale and pogonion.

18.LI E : Incisal tip of mandibular central incisor.

19.LI A : Lower incisor root apex.

20.L6 D : Most distal point of the distal surface of mandibular first molar crown.

**Cephalometric planes:** used in this study (fig VI:b)

1.Palatal plane (ANS-PNS plane) : It is a line from the anterior nasal spine to posterior nasal spine. It will be used as reference plane to find out any change in vertical plane.

2.Pterygoid vertical plane(Ptv plane): A vertical line drawn through the distal radiographic outline of the pterygomaxillary fissure and perpendicular to Frankfort horizontal plane.It will be used as reference plane to evaluate any change in sagittal plane.

3.S-N plane : It is the cranial line between Sella and Nasion. It represents the anterior cranial base and will also be used as reference plane.

| | |
|---|---|
| 4.Basion-Nasion plane(Ba Nplane) | : It is the line connecting the Basion and Nasion point. It represents the cranial base. |
| 5.Facial axis | : A line extanding from the foramen rotundum (Pt) to cephalometric Gnathion. |
| 6.Facial plane | : It is a line from the anterior point of the frontonasal suture (Nasion) to the most anterior point of the mandible (Pogonion). |
| 7.Frankfort horizontal plane (FH) | : It is a horizontal plane extending from Porion to Orbitale. |
| 8.Mandibular plane (MP) | : It is a line extending from Gonion to Menton. |
| 9.E plane | : The esthetic line or plane extending from the soft tissue tip of the nose to the soft tissue chin point. |

Figure VI:a- CEPHALOMETRIC LANDMARKS

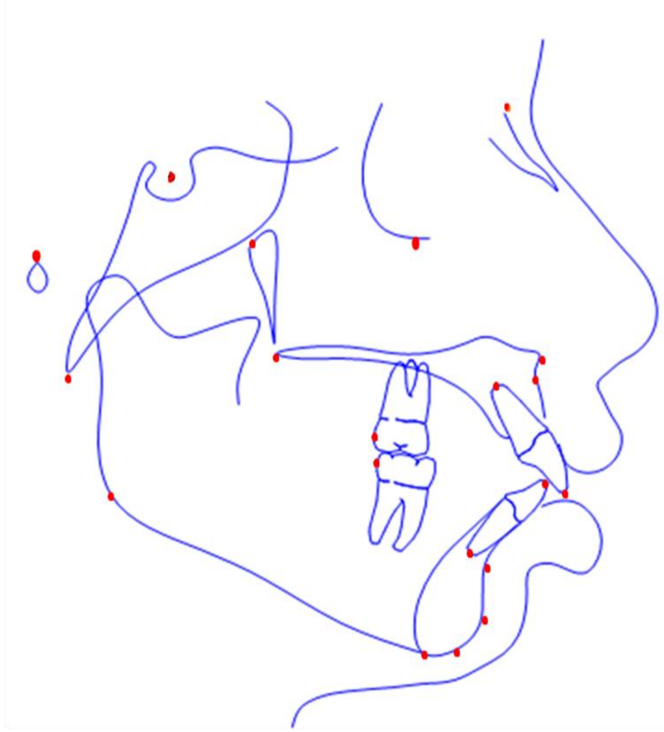
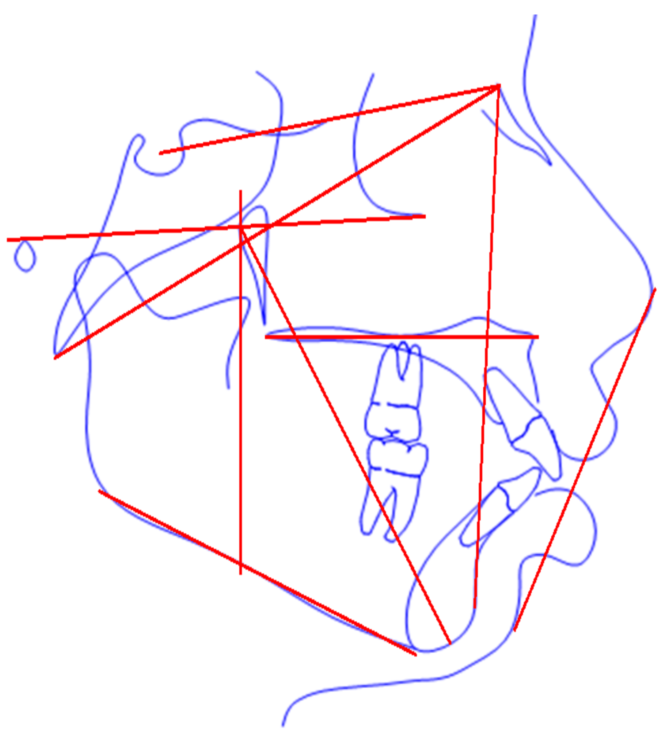


Figure VI:b- CEPHALOMETRIC PLANE



Conventional lateral cephalometric radiographs were taken before the start of retraction and after the en-masse retraction of the anteriors for both the study and the control group. To differentiate between the right and left side molar on lateral cephalograms, a 0.017X0.025 inch stainless steel wire bent in an L shape with 0.5cm horizontal and and 1cm vertical length was inserted from the mesial side in the buccal tube of the left upper and lower molars inserted from mesial open end. Similar stainless steel wire bent with an additional horizontal arm of 0.5cm in length was also inserted from the mesial open end of the buccal tube of the right upper and lower molars. These markers helped to differentiate the right and left side molars on the orthopantamogram (fig.V: c,d).

**Methodology for evaluation of extraction space closure in the dental cast:**

Initial measurements were done after extraction using a digital vernier caliper at the maximum contour of the the mesial point of second premolar and the distal maximum contour of the canine on the study models taken at the end of every month interval. Space closure was later co-related with the molar anchor loss values and the the effective en-masse retraction percentage was calculated.

**Methodology for evaluation of retraction and anchor loss:**

**Maxilla**

In the maxilla the linear measurements was taken from pterygoid vertical along the Frank fort horizontal plane. The horizontal distance from pterygoid vertical to the jig on the molar was used to assess anchorage loss on both sides in the study group and the control group. (Fig.V: c,d) The same reference line was used to assess the retraction of incisors with the horizontal distance distance measured to the central incisor bracket to cross check the space closure.

**Mandible**

In the mandible the linear measurements were taken from sella vertical along the SN plane. The horizontal distance from the sella vertical to the jig on the molar was used to assess anchorage loss on both the side in the study and in the control group. (Fig.V: c,d)

The same reference line was used to assess the retraction of incisors with the horizontal distance measured to the central incisor bracket.

The dental cast measurements were correlated with the amount of anterior retraction. Mean of these were taken as the amount of space closure.

**Measurement of cephalometric error**

1.Error due to fatigue : 5-10 cephalograms were analyzed on an average in a day to eliminate the error due to fatigue of investigator.

2.Inter-investigator error : All the cephalograms were traced and analyzed by a single investigator.

**Comparison with the conventional group for en-masse retraction:**

The conventional group was treated with the first premolar extraction and Niti coil spring retraction, were compared similarly before the start of retraction. The time taken for space closure in the corticotomy group were compared with the space closure in the conventional group. Efficiency of corticotomy group was thus compared with the conventional group.

**Statistical analysis:**

All statistical analysis was performed by using SPSS software package (SPSS for Windows XP, version 17.0, Chicago). For each variable measured on the lateral cephalogram, the mean and the standard deviation were calculated.

**Independent T Test** was used to determine statistical significance of difference between the rate of retraction, molar anchor loss before retraction (T1) and after retraction (T2) between the study group and the control group.

**One way Anova followed by Tukey HSD test** was done to evaluate and compare the rate of space closure and anchor loss between the studied monthly time interval.

**$P < 0.05$** was considered statistically significant

# RESULTS

The study was conducted to evaluate the efficiency and nature of corticotomy assisted en-masse retraction compared with the conventional method of en-masse retraction of the anteriors in bimaxillary protrusion patients. The results are based on 14 patients equally divided into two groups, Study group (Corticotomy group) and Control group(Control group) irrespective of sex in the age range of 20 years ±2.5 years. All patients were selected from the patients who reported to the Department of Orthodontics at Ragas Dental College and Hospital, Chennai, India, between January and June 2012.

The results are discussed under the following headings:

**DURATION AND RATE OF RETRACTION:**

**Maxilla:**

There was no significant difference between the extraction spaces in the maxilla between the study group and the control group.

- 93.5% of extraction space closure was achieved by the end of $4^{th}$ month in the Study group (Corticotomy group).
- 54.5% of extraction space closure was achieved during the same time period, end of $4^{th}$ month in the Control group (Conventional group).
- Average rate of space closure of 1.8mm/month was achieved in the Study group.
- Average rate of space closure of 1.02mm/month was achieved in the Control group.

**Mandible:**

There was no significant difference between the extraction spaces in the mandible between the study group and the control group.

- 92.6% of extraction space closure was achieved by the end of $4^{th}$ month in the Study group (Corticotomy group).
- 51.7% of extraction space closure was achieved during the same time period, end of $4^{th}$ month in the Control group (Conventional group).
- Average rate of space closure of 1.57mm/month was achieved in the Study group.
- Average rate of space closure of 0.87mm/month was achieved in the Control group.

**Comparison of rate of space closure in the Maxilla and Mandible at monthly intervals:**

- Acceleration of rate of space closure was statistically significant during the first two months of retraction in the study group.
- No significant rate of acceleration was found in the maxilla and/or the mandible during the month intervals in the control group.
- No significant difference was found in the rate of space closure at monthly intervals in the Control group.

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## ANCHOR LOSS:

### Maxilla:

- Molar anchor loss of approximately 0.39mm occurred during the anterior retraction in the study group within the assessed time period.
- Molar anchor loss of approximately 1.47mm occurred during the anterior retraction in the control group within the assessed time period.

### Mandible:

- Molar anchor loss of approximately 0.39mm occurred during the anterior retraction in the study group within the assessed time period.
- Molar anchor loss of approximately 1.6mm occurred during the anterior retraction in the control group within the assessed time period.

### Comparison of anchor loss:

- Statistically significant difference was present in the anchor loss between the Study group and the Control group.
- The amount of anchor loss increased as time advanced in the Study group.
- No significant difference in the amount of anchor loss between the monthly intervals was found in the Control group.

**Table 1: Rate of retraction in the Maxilla and Mandible compared during monthly intervals in Study and Control group.**

| ARCH | MONTH | GROUP | MEAN | S.D | P VALUE |
|---|---|---|---|---|---|
| **MAXILLA** | Start of retraction | Control group<br>Study group | 7.51<br>7.76 | .08<br>.25 | 0.062 |
| | 0-1 | Control group<br>Study group | 6.64<br>5.93 | .35<br>.22 | 0.006** |
| | 1-2 | Control group<br>Study group | 5.55<br>3.92 | .53<br>.24 | <0.001** |
| | 2-3 | Control group<br>Study group | 4.52<br>2.22 | .53<br>.23 | 0.008** |
| | 3-4 | Control group<br>Study group | 3.41<br>.5 | .51<br>.25 | 0.062* |
| **MANDIBLE** | Start of retraction | Control group<br>Study group | 6.75<br>6.79 | .36<br>.22 | 0.821 |
| | 0-1 | Control group<br>Study group | 6.08<br>5.08 | .41<br>.23 | 0.037** |
| | 1-2 | Control group<br>Study group | 5.11<br>3.22 | .45<br>.22 | <0.001** |
| | 2-3 | Control group<br>Study group | 4.24<br>1.61 | .52<br>.49 | 0.030* |
| | 3-4 | Control group<br>Study group | 3.26<br>.5 | .61<br>.47 | 0.052* |

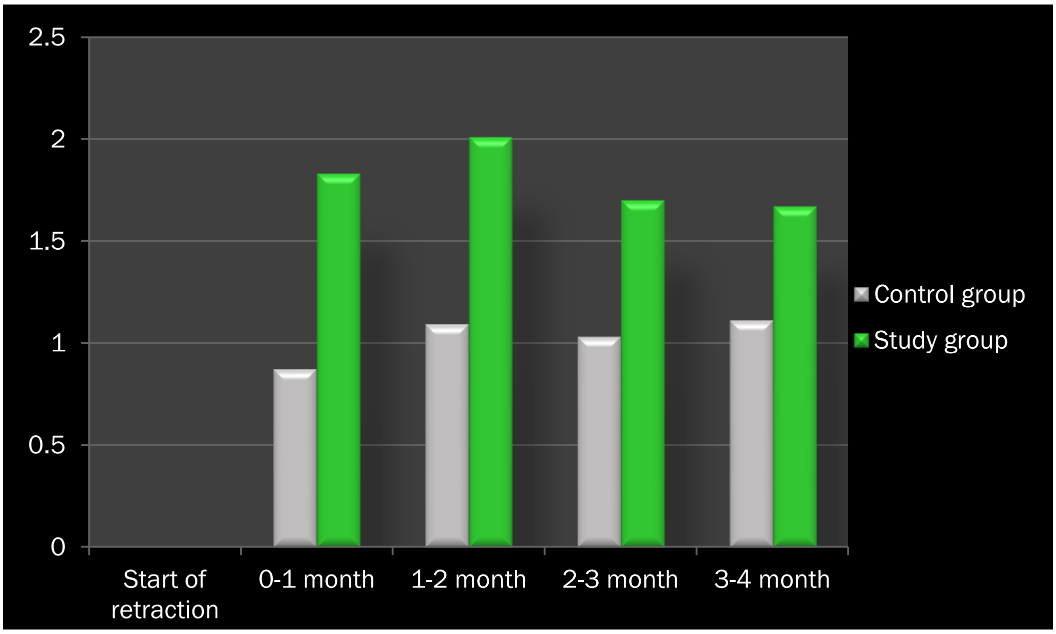
NS: Not significant;
*p < 0.05 (statistically significant);
**p < 0.001 (statistically highly significant)

**Table 3: Molar anchor loss in the Maxilla and mandible compared between the study and the control group (mm)**

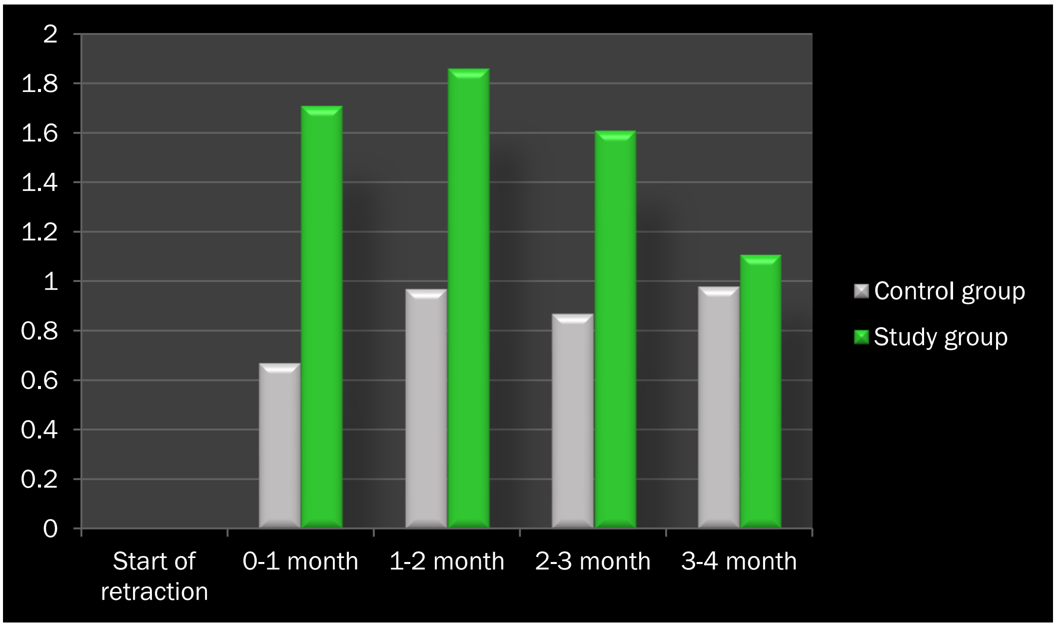
| ARCH | MONTH INTERVALS | GROUP | MEAN | S.D | P VALUE |
|---|---|---|---|---|---|
| **MAXILLA** | 0-2 | Control group<br>Study group | .36<br>.00 | .16<br>.00 | 0.001** |
| | 2-4 | Control group<br>Study group | .42<br>.06 | .10<br>.09 | <0.001** |
| | 4-6 | Control group<br>Study group | .41<br>.33 | .12<br>.17 | 0.417 |
| **MANDIBLE** | 0-2 | Control group<br>Study group | .64<br>.00 | .33<br>.00 | 0.001** |
| | 2-4 | Control group<br>Study group | .33<br>.08 | .10<br>.04 | 0.002** |
| | 4-6 | Control group<br>Study group | .63<br>.31 | .17<br>.15 | 0.013* |

NS: Not significant;
*p < 0.05 (statistically significant);
**p < 0.001 (statistically highly significant)

**Graph 1: Rate of retraction in the maxilla compared between the study and the control group**

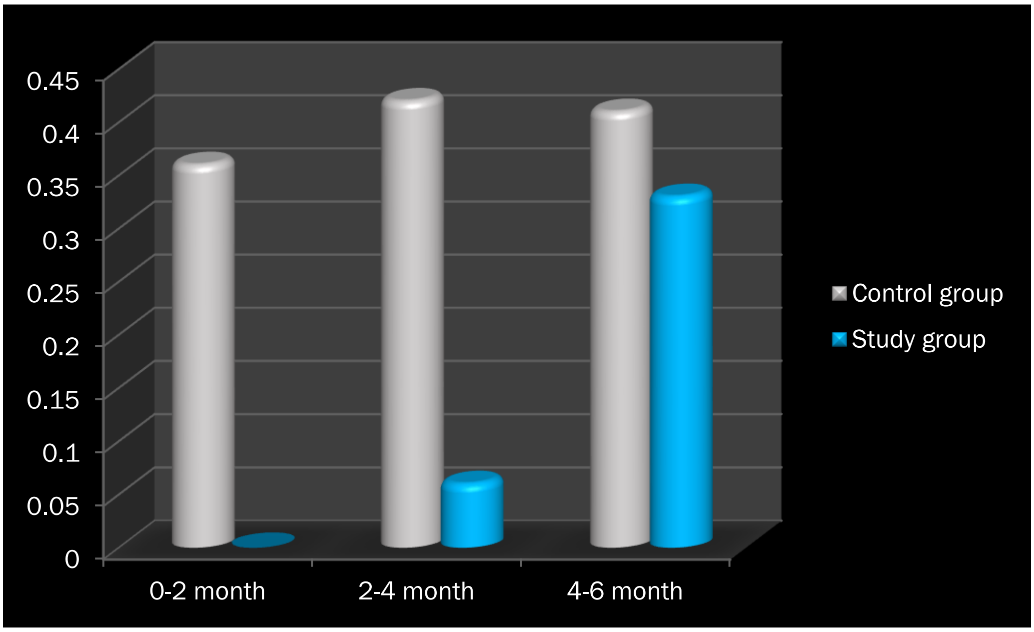



**Graph 2. Rate of retraction in the Mandible compared between the study and the control group**

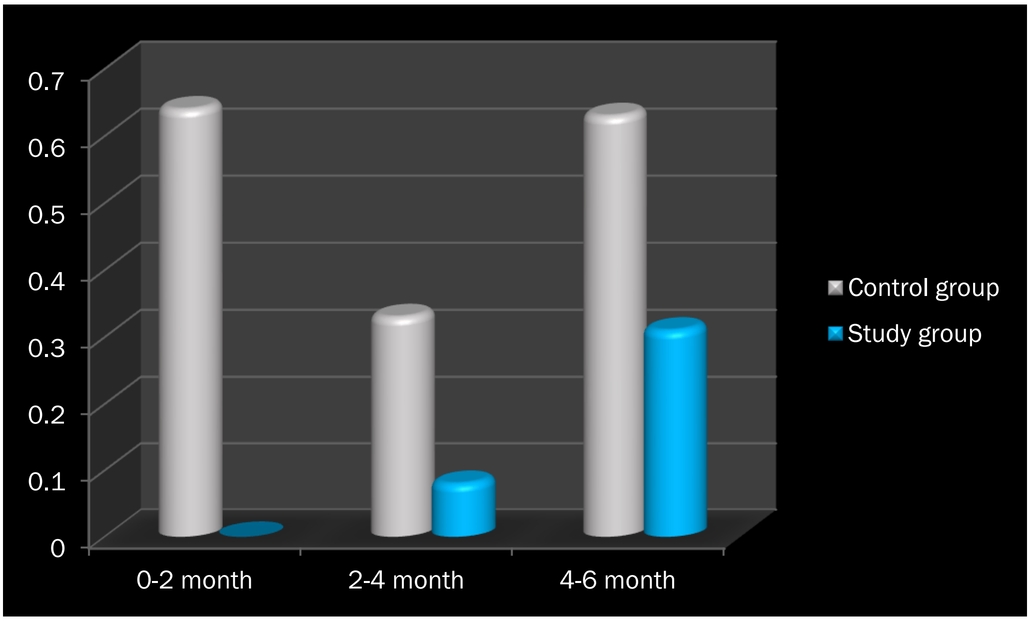



Graph 1 and 2 showing rate of extraction space closure during every month interval compared between the study and the control group, with month intervals on the X axis and the rate of retraction in mm on the y axis.

**Graph 3: Molar anchor loss in the Maxilla compared between the control and the study group**



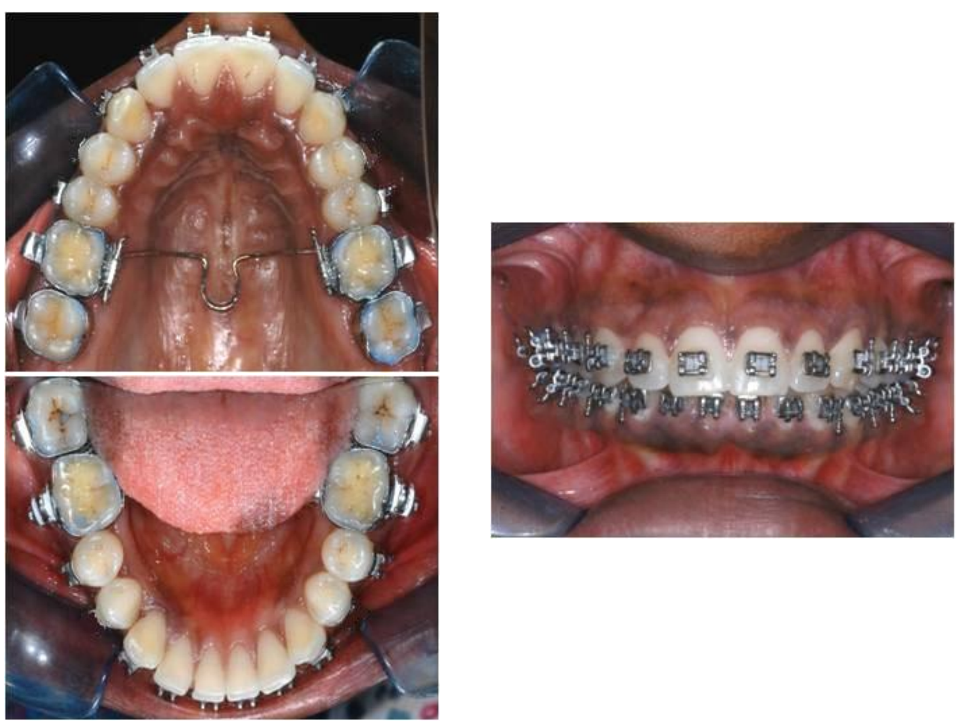

**Graph 4: Molar anchor loss in Mandible compared between the study and the control group**



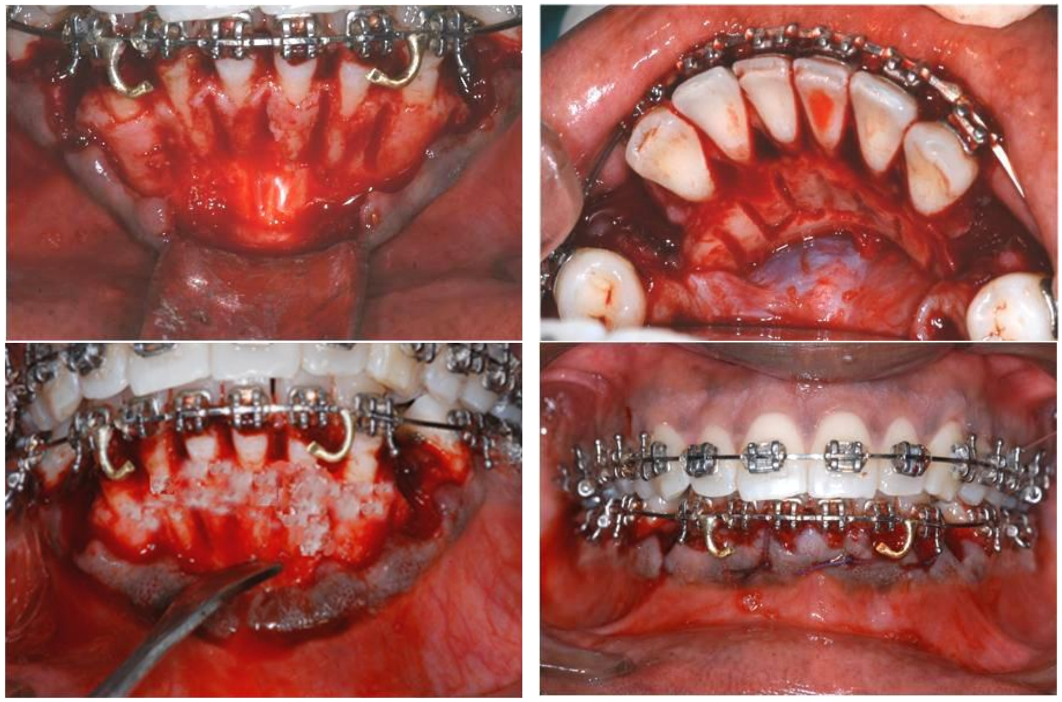

Graph 3 and 4 showing the amount of anchor loss compared between the control and the study group, with month intervals on axis and amount of anchor loss on Y –axis in mm.

# REPRESENTATIVE CASE NO.1: STUDY GROUP

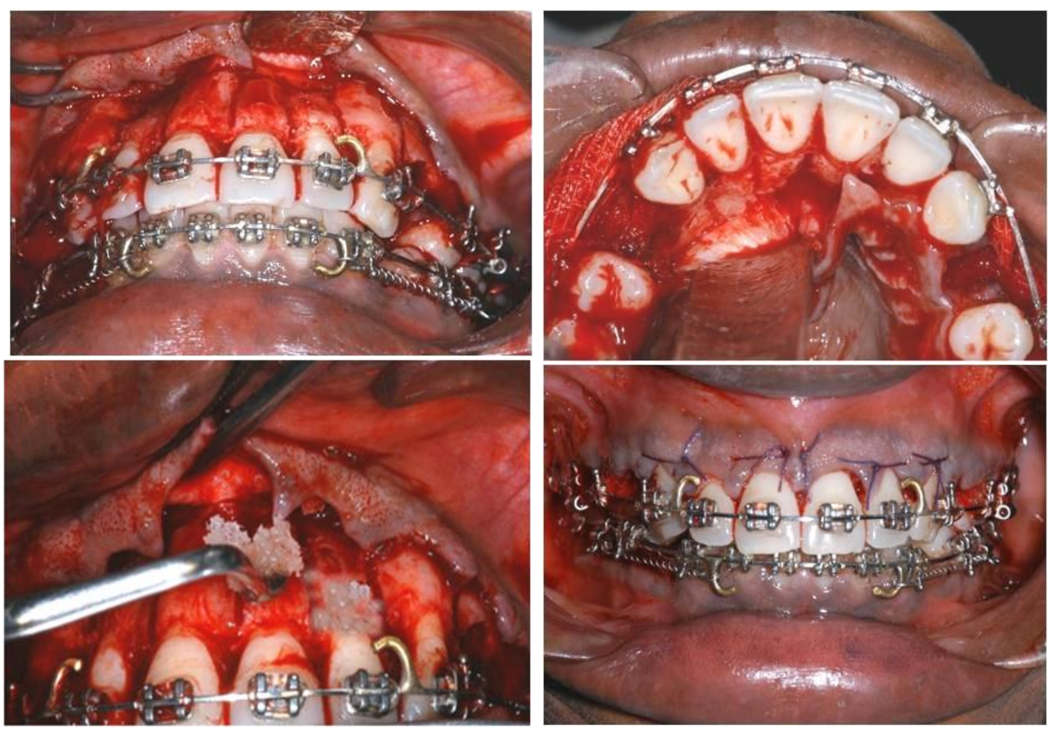
PRE TREATMENT INTRA ORAL PHOTOGRAPH



Leveled and aligned without extraction of first premolars



CORTICOTOMY- MANDIBULAR ARCH

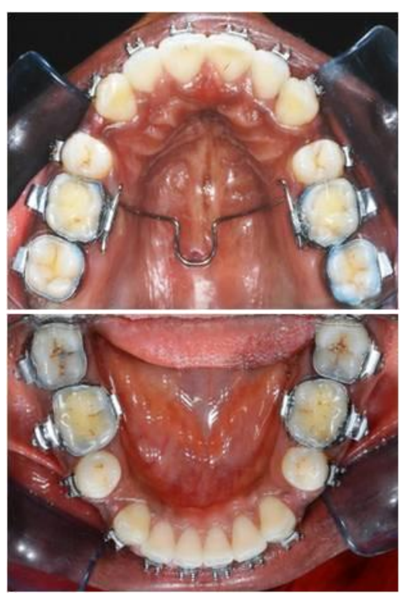


CORTICOTOMY- MAXILLARY ARCH

Start of retraction (T1)

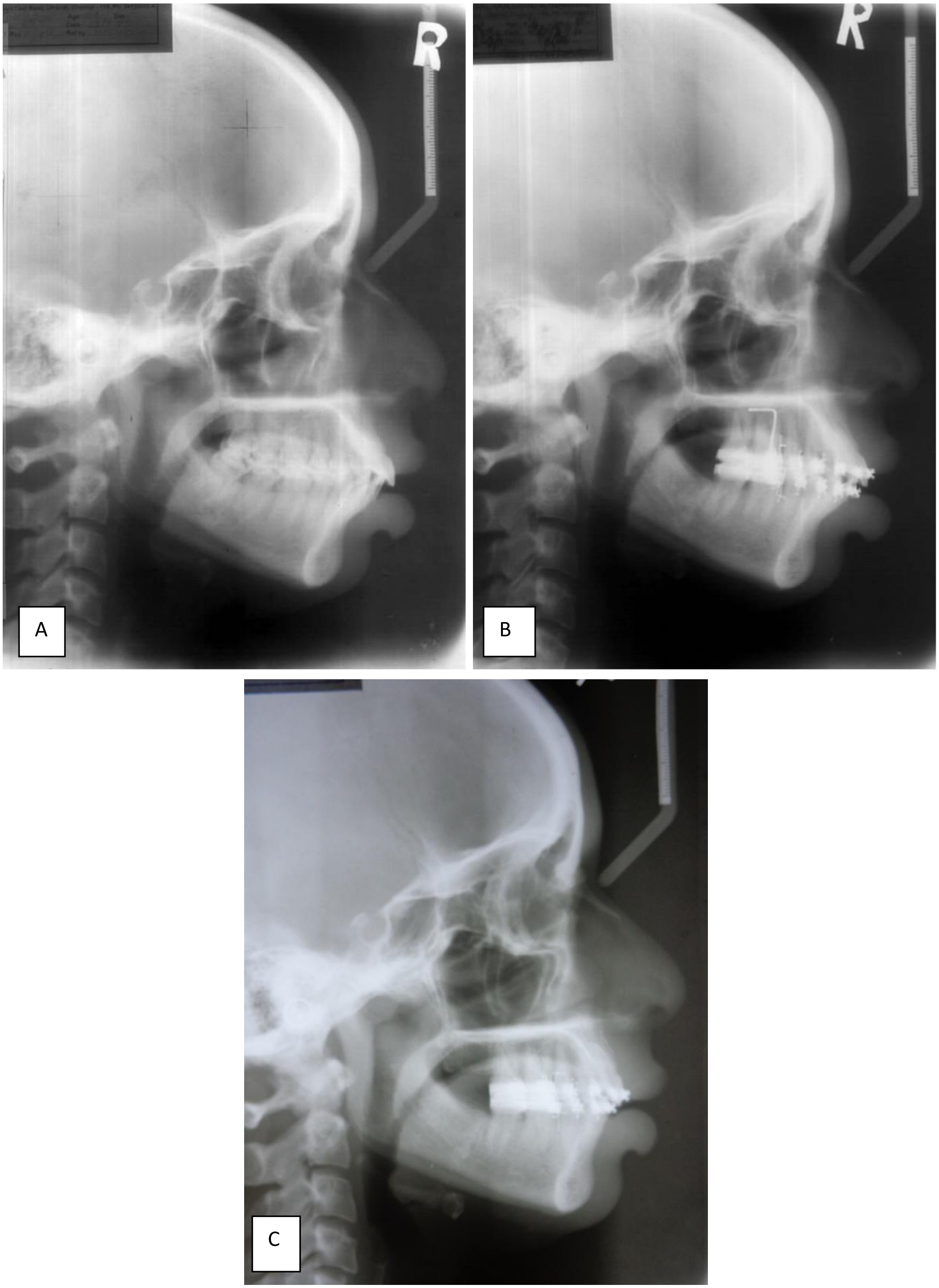
End of space closure (T2): 3-4 months

0-1 month



1-2 month

2-3 month



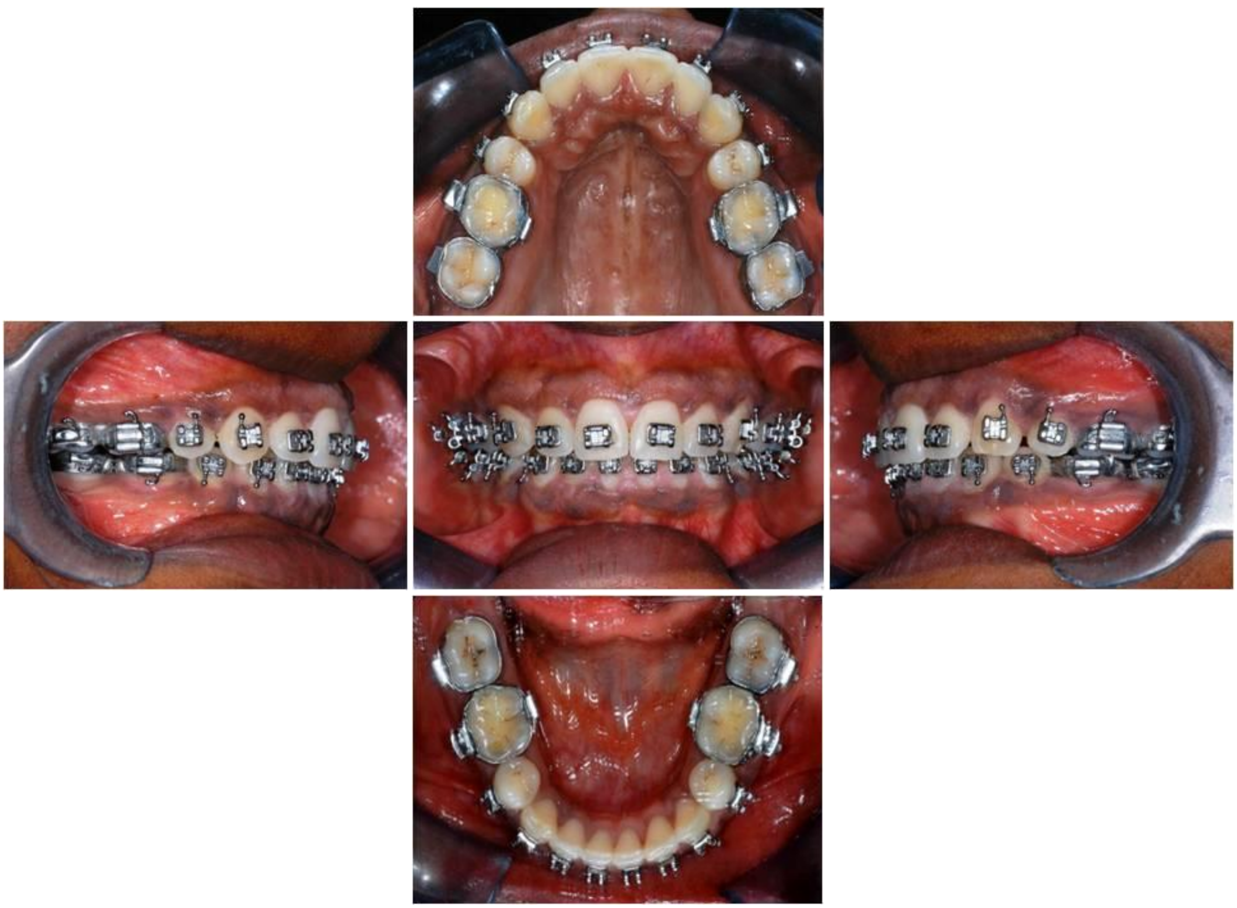

A: Pre treatment B: Pre retraction C: Post retraction

**COMPARISON OF PRE AND POST RETRACTION EXTRAORAL PHOTOGRAPHS**

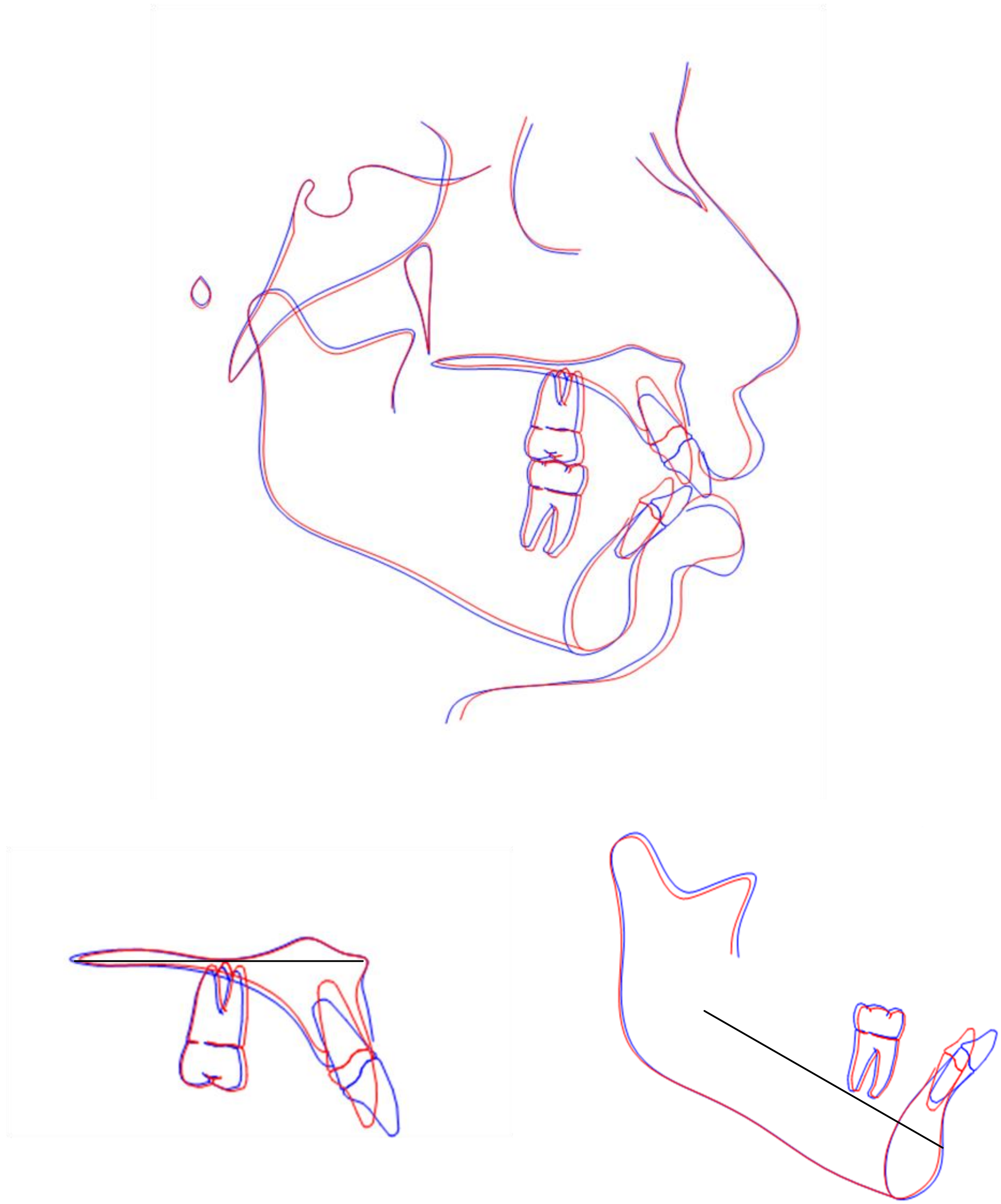
PRE TREATMENT EXTRAORAL PHOTOGRAPH

POST RETRACTION EXTRA ORAL PHOTOGRAPH

PROFILE CHANGE



POST RETRACTION INTRAORAL PHOTOGRAPH



PRE RETRACTION

POST RETRACTION

PRE RETRACTION AND POST RETRACTION CEPHALOMETRIC SUPERIMPOSITION

Skeletal parameters for representative case no. 1: Pre and post retraction comparison

| CEPHALOMETRIC VARIABLES | PRE RETRACTION (T1) | POST RETRACTION (T2) | DIFFERENCE |
|---|---|---|---|
| SNA | 85˚ | 83˚ | 2˚ |
| SNB | 81˚ | 79˚ | 1˚ |
| ANB | 6˚ | 4˚ | 2˚ |
| Facial axis angle | -1˚ | 1˚ | 2˚ |
| N perp. to Point A | 5mm | 2mm | 3mm |
| SN- GoGn | 34˚ | 33˚ | 1˚ |
| Y axis | 68˚ | 66˚ | 2˚ |
| Lower anterior face height | 72mm | 71mm | 1mm |

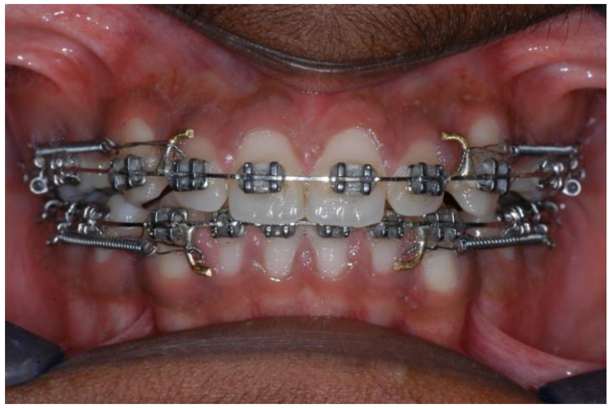
Dental parameters for representative case no.1: Pre and post retraction comparison

| CEPHALOMETRIC VARIABLES | PRE RETRACTION (T1) | POST RETRACTION (T2) | DIFFERENCE |
|---|---|---|---|
| UI to NA(mm) | 32˚ | 24˚ | 8˚ |
| UI to NA(˚) | 10mm | 4mm | 6mm |
| UI to SN (˚) | 112˚ | 101˚ | 11˚ |
| LI to NB(mm) | 36˚ | 26˚ | 10˚ |
| LI to NB(˚) | 12mm | 5mm | 7mm |
| LI to Mnd. Plane | 102˚ | 92˚ | 10˚ |
| E line to UL | 10mm | 2mm | 8mm |
| E line to LL | 12mm | 4mm | 8mm |

## REPRESENTATIVE CASE NO.1: CONTROL GROUP

PRE TREATMENT INTRAORAL PHOTOGRAPH

LEVELING AND ALIGNING

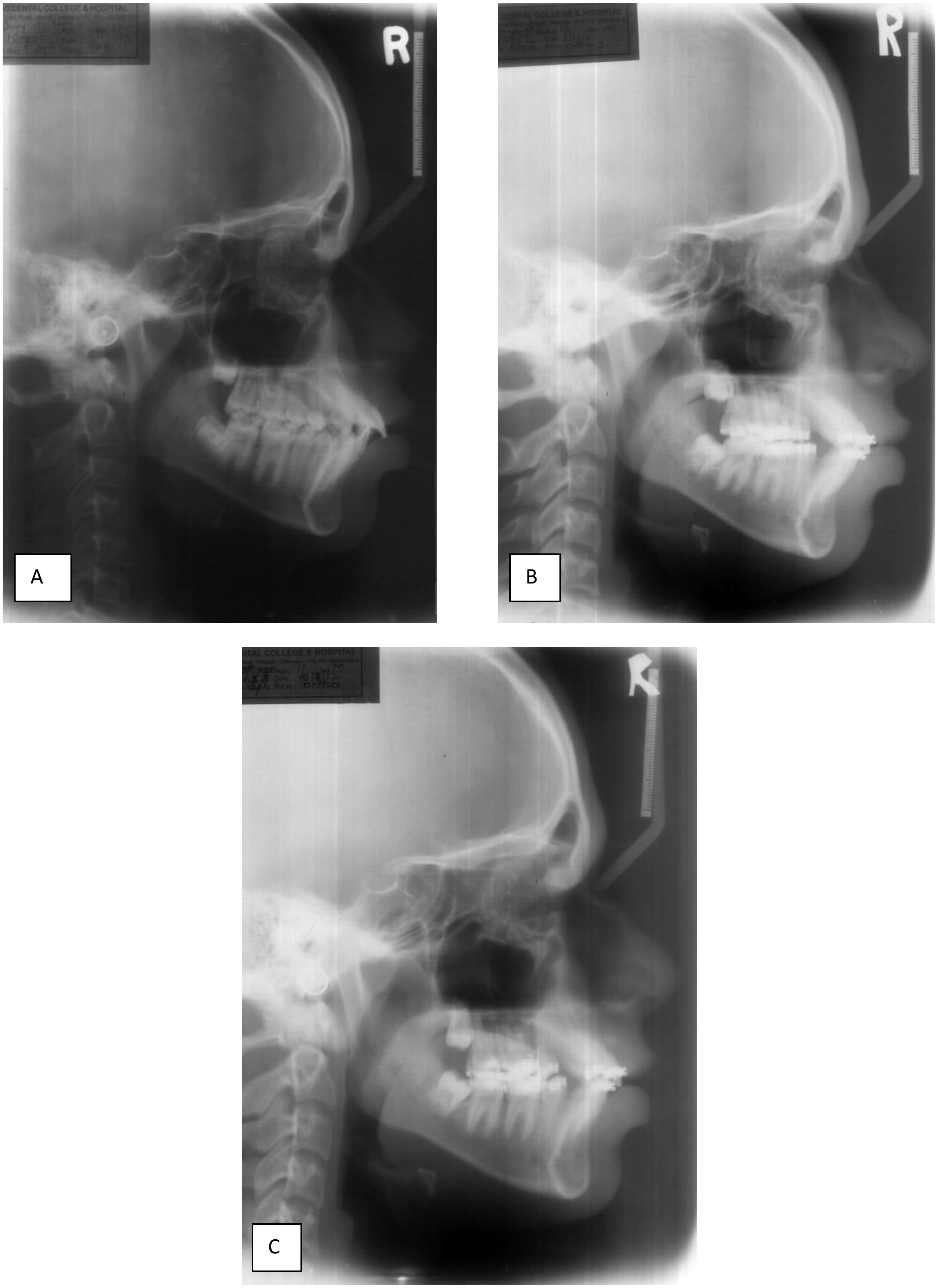


START OF RETRACTION

2 months Post Retraction

3 months Post Retraction

4 months Post Retraction




A: PRE TREATMENT | B:PRE RETRACTION | C:4 MONTHS POST RETRACTION

# DISCUSSION

In the treatment of bimaxillary protrusion, two important factors for consideration are: esthetic improvement of the dentofacial area and the establishment of the stable dental relationship that embodies the requirement of line of occlusion. Because of the negative perception of protrusive dentition and lips many patients with bimaxillary protrusion seek orthodontic care to decrease this procumbency.[8] The treatment approach usually consists of extracting the four first premolars and retracting the anterior teeth with maximum anchorage mechanics. Maximum anchorage of posterior teeth allows the anterior teeth to be retracted to the greatest extent. Time is an important factor during the course of orthodontic treatment.[18]

**Dimitrios Mavreas**[18] in a systematic review revealed that extraction treatment takes longer time than non-extraction treatment where in those involving four premolar extractions took the longest duration of approximately 18.6 months and anterior retraction alone, took more than 8 months.

**Hu Long**[46] evaluated the effectiveness of interventions on accelerating orthodontic tooth movement and the systematic review revealed that: Low-level laser therapy was ineffective to accelerate orthodontic tooth movement, evidence is still not conclusive whether electrical current and pulsed electromagnetic fields can defenetively accelerate tooth movement, Dentoalveolar or periodontal distraction is a promising method to accelerate orthodontic tooth movement but lacks convincing evidence. Whereas Corticotomy is documented to be a effective and safe procedure to accelerate orthodontic tooth movement. Therefore corticotomy facilitated technique was used in the current study as documented evidences proved it to be a safe modality for intervention to accelerate orthodontic tooth movement.

Among the fundamental components of dentofacial problem, Dentoalveolar is defined as "is relating to or involving the teeth and their sockets"[17] which is interpreted as the relationship of the teeth to the alveolar bone housing the teeth. The alveoloskeletal component involves relationship of the dentoalveolar complex to its skeletal base, interpreted as dentoalveolar complex that does not align properly with its associated skeletal base. Kole suggested that the greatest resistance to tooth movement is created by cortical bone of the alveolus especially buccal and lingual to the apices of the teeth referred to as the "Orthodontic Walls".[64]

Corticotomy is a surgical technique in which only the cortical bone is cut, perforated or mechanically altered to the depth of the medullary bone and the medullary bone remains intact. Corticotomy (selective alveoloar decortictation) can be effectively used to correct dentoalveolar and moderate alveoloskeletal problems. As the severity increases from alveoloskeletal to pure skeletal problems osteotomy and/or distraction osteogenesis would be the choice of treatment.[64]

**Chung et al**[10] claims that corticotomies when combined with heavy forces leads to histologic changes called the Compression osteogenesis where the medullary bone is more plastic and malleable (temporary osteopenia). They produce effective acceleratory orthodontic rotation and tipping movement. The high medullary bone turnover in healthy tissues results in new bone formation with low bone density the key which provides more rapid tooth movement. Thus the type of tooth movement in corticotomy assisted retraction is dentoalveolar with tipping followed by uprighting .

There is considerable amount of evidence in the literature as given by **William M. Wilcko**[94], **Raffaele spena**[62], **Fischer**[84], **Dauro Douglas Oliveira**[15], **Mostafa et al**[55], **Generson and Porter**,[23] **Chung et al**[9], **Ali H Hassan**[1], **Hyo-Won Ahn**[30], **Shoichiro Iino**[67] and many others suggesting that corticotomy is a viable option for accelerating orthodontic treatment.

However there is very little reference to the treatment efficiency of selective alveolar decortication for en-masse retraction of anteriors especially in bimaxillary protrusion patients.

This study differs from other previous studies as the en-masse retraction of anteriors using sliding mechanics to assess the efficiency of the corticotomy assisted retraction was assessed with a modified protocol which was compared with the conventional en-masse retraction in bimaxillary protrusion patients.

**Thomas M.Wilcko**[49] proposed a basic protocol where in orthodontic brackets are placed and a light wire engaged sometime during the week before the surgery with subsequent orthodontic adjustments being made at 2-week intervals. This flexible light wire would bring about faster tipping movements which he used to accelerate, primarily to decrowd the dentition. Whereas in our study the case required all first premolar extraction primarily to bring about faster controlled anterior retraction and not to level and align the arches, therefore Wilcko's protocol was modified where in corticotomy was performed only after leveling and aligning was completed just before retraction. The teeth was stabilized with a rigid stainless steel wire (0.019"X 0.025" ) to prevent torque loss and to bring about bodily /controlled tipping movements during retraction. The posterior segment (second premolar, first molar and second molar) were not decorticated since osteopenia is required only 2-3mm around the teeth to be moved and also to act as an anchorage module.

In **Wilcko**'s[48] protocol corticotomy was performed prior to aligning and an additional procedure namely Ostectomy (surgical removal of cortical plate) in the extraction space was required which is both cumbersome and expensive to the patient because of additional grafting required in the area. The outcome is also not much significantly different from other studies were corticotomy was employed.

Corticotomy-facilitated tooth movement was first described by **L.C. Bryan** in 1893, **Cohn Stock**[11] surgically removed the palatal bone to retract single/ multiple teeth. **Bichlmayr**[5] described a corticotomy procedure for adult bimaxillary protrusion patient requiring all first bicuspid extraction by excising the buccal and lingual cortical plates at the extraction site. **Skogborg and Ascher**[80] divided the interdental bone (septotomy). **Neuman**[59] divided the interdental bone and ablated wedge of bone palatal to the teeth to be retracted. **Köle's**[38] technique consisted of buccal and lingual interproximal vertical corticotomy cuts limited to cortical layers, with these vertical corticotomy cuts being connected by horizontal osteotomy cuts approximately 1 mm beyond the apices of the roots, but the bucco lingual communication that was the stansard procedure in Kole's technique is considered to be morbid. **Suya** replaced supraapical horizontal osteotomy with horizontal corticotomy to facilitate luxation of the corticotimized bone blocks. **Kretz**[39] described that therapeutic fracture of the anterior alveolus, again which is aggressive bone manipulation that could compromise the vascularity. **Bell and Levy**[4] luxated the operated tooth bone segment with a chisel which had been documented to lead to ischemia in the area. **Germec**[24] used minimal intervention by limiting corticotomy only on the labial surface of bone where labial movement of teeth was desired but acceleration duration started to slow down very easily. **Wilcko and Ferguson**[19] collaborated and reiterated the fact that no luxation of the bone was required as they considered luxation to be a mechanical misapprehension. They further modified the corticotomy-assisted orthodontic technique with the addition of alveolar augmentation. Therefore the Wilcko- Ferguson technique is dependent upon the cortical bone thickness than on any preconceived pattern of bone injury such as cuts and dots or a combination of both was used. Surgical scarring barely penetrated the cortical bone without involving the medullary bone. The procedure employed in our study has the advantage of being less invasive, is done under local anesthesia and is a simpler technique.

**Derya Germec**[24] carried out corticotomy for lower incisor retraction done only under local anesthesia. Thus the surgical procedure in our study was carried under local anesthesia where full-thickness flaps are reflected labially and lingually using a sulcular releasing incision. Vertical releasing incisions were used if sufficient underlying bone was not accessible. The incision was located distal to the area where corticotomy cuts were planned.

In our study 701 tapering fissure bur for interdental scoring and no.2 round bur for punch hole perforation was used which is an acceptable method for decortications. [25,55,8]

As proposed by **Neal C Murphy,**[57] the demineralized bone matrix was used to augment when dehiscence or fenestration was noted as when the quality and quantity of bone was questionable. Demineralized freeze dried allogenic bone graft (Rocky mountain) was used as it has more of osteoinductive (stimulation of osteoprogenitor cells to differentiate into osteoblasts that then begin new bone formation) which stimulates BMP formation was used. Approximately 1-2cc of particulate graft mixed with sterile saline was required per arch.

A few case reports: **Derya Germec**[24], **Seong Hun Kim**[72] , **Waranee Linlawan**[95], **Aboul Ela et al**[73], **Schoihiro lino**[74], **Lee etal** [71]are available in the literature suggesting that corticotomy can be beneficial in bimaxillary protrusion cases. Most of these studies employ either an implant or involves independent canine retraction. Hence we chose to employ bimaxillary cases, since they require maximum anchorage and extended treatment duration.

The molar anchor loss value had not been documented convincingly for such corticotomy assisted retraction. Therefore our study aimed to evaluate the rate of retraction and the amount of molar anchor loss that occurred during the retraction period. Control group were evaluated for the same period from start to finish of retraction period as in the corticotomy group. Molar anchor loss studied at certain monthly intervals served to find the ability of the molars to effectively serve as an anchorage source as to whether they can be relied as an absolute anchorage source for such bimaxillary protrusion condition. Temporary anchorage devices was not used to assess whether the undecorticated posterior teeth can act as an anchorage module.

The duration and rate of retraction in the study group was assessed with the help of study models. The space closure was assessed between the maximum contour distal to the canine and mesial surface of the second premolar. **Ziegler and Ingervall**[77] used the posterior rugae and the midpalatal raphe as reference point and line whereas **Lotzof eta al**[47] designed an acrylic mold of the anterior palate and two wires projected to the central fossa of first molar, to assess molar anchor loss during canine retraction. The palatal rugae or no other special transferable reference acrylic mold was fabricated to assess anchor loss, since the palatal flap was also reflected and sutured back and would not serve as a reliable landmark after the corticotomy procedure. Anchor loss was assessed with the help of lateral cephalogram similar to the method proposed by **Badri Thiruvengadachari**[2] with modified jigs placed on the upper and lower, right and left first molar to differentiate the right from the left molar. Anchor loss was correlated with the space closure and effective retraction in the Study group was assessed and compared with the control group for the same period of time as the study group (approximately 4-5 months).

**Fink and Smith**[21] in a retrospective comparative study observed that non-extraction cases took, on an average 21.95 months, two premolar extraction cases 25 months, and four premolar extraction cases 26.18 months time period to get completed and **Dimitrios Mavreas**[18] in a systematic review correlated that the longer treatment time was required for extraction cases and this was proportional to the number of teeth extracted.

In our study there was no significant difference in the extraction space in the study and the control group which accounted to be, on an average of 7.63mm in the maxilla and 6.77mm in the mandible inspite of early extraction in the control group when compared with the study group which could be due to the fact that the cases selected for the study had minimal crowding. Thus the study and the control group can be effectively compared.

93.5% (7.26mm) of extraction space closure was achieved by the end of 4$^{th}$ month in the Study group (Corticotomy group). Definitive space closure was achieved in the maxilla by 4-5 months. Whereas only 54.5% (4.1mm) of extraction space closure was achieved in the control group for the same period of time i.e by the end of fourth month. 92.6% (6.29mm) of extraction space closure in the mandible was achieved by the end of 4$^{th}$ month in the Study group (Corticotomy group). Whereas only 51.7% (3.5mm) of extraction space closure was achieved in the control group for the same period of time i.e by the end of fourth month**. Derya Germec**[24] attained retraction of lower incisors alone into the residual spaces remaining after decrowding and segmental canine retraction took almost 1 ½ months for space closure with corticotomy assisted retraction using loop mechanis, the surgery was an extensive invasive procedure when compared with the present study. **Chung et al**[9] reported that the complete retraction of anterior teeth combined with corticotomy in a case with severe bimaxillary protrusion took less than 3½ months and **Seo et al**[71] reported that in case of bimaxillary protrusion using anterior corticotomized segment required five months for complete retraction with the help of C-lingual retractor, **Schoihiro Lino**[74] reported that it took about 7 months for completion of space closure.

The rate of retraction in our study correlates with the outcome reported by others. However the fact that no Temporary anchorage devices (TAD) were used in our study in contrast to the above studies along with the time of intervention for corticotomy highlights the significance of this modification. Wherein only a modified corticotomy without the aid of TAD supported anchorage not only accelerates the rate of retraction of tooth movement but also does not tax the anchorage.

The average rate of space closure was 1.8mm/month in the maxilla and 1.6mm/month in the mandible in the Study group. This correlates with the studies of **Aboul Ela et al**[73] who calculated the mean rates of individual maxillary canine retraction with buccal corticotomy alone and a retraction force of 150 grams was on an average about 1.42mm/ month.

An average rate of space closure was 1.02mm/month in the maxilla and 0.87mm/month in the mandible in the control group. **Dixon et al**[89] in a previous study used Niti coil spring delivering 200grams force for retraction which showed the highest rate of space closure of about 0.81mm/ month and attained 32% of extraction space closure by the 4th month. The rate of space closure per month in the control group is highly correlative but approximately 51% of extraction space closure by 4th month was closed in our study could possibly be because of marginally higher forces and a more efficient protocol for en-masse retraction.

Though the average rate of retraction in the study group was 1.8mm/month in the maxilla and 1.6mm in the mandible there was a peak increase during the first two months of retraction in the maxilla (2.01mm/month) and in the mandible (1.86mm/month) which started to reduce by the end of fourth month . This finding is in concurrence with that of **Aboul Ela et al**[73] who reported that the rate of space closure peaked during the end of 1st and 2nd month and reduced by the end of 4th month. This could be biologically co-related with the transient RAP phenomenon as mentioned by **Frost**[26] **which** remains active for 4 months.Thus the time period assessment of retraction for the first four month period after corticotomy can be substantiated.There was no significant difference in the rate of retraction in control group when assessed between monthly intervals.

An average anchor loss of 0.39mm occurred in the maxilla and in the mandible for a maximum of 4 to 6 months. There is no pertinent literature to substantiate molar anchor loss in corticotomy assisted retraction as most of the study used temporary anchorage devices for retraction purposes and hence there was no anchor loss. Our study would be the first study to correlate pure anchor loss and the efficiency of the undecorticated posterior segment to act as an efficient anchorage source.

Whereas molar anchor loss of 1.47mm in the maxilla and 1.6mm in the mandible occurred in the control group within the same time period assessed. Similarly in a previous study on conventional en-masse retraction by **Wook Heo**[96] approximately 4mm of retraction of upper incisal edge resulted in 1mm of anchor loss in the upper molar. Since the complete space closure in the control group was not assessed in the current study ther could be further anchor loss at the end of retraction. **Vikas Agarwal**[91] in a previous study reported molar anchorage loss of 2.45mm**.** **Thiruvenkatachari et al**[2] reported an anchorage loss of 1.6mm in the maxilla and 1.7mm in the mandible when molars were used as anchorage unit for anterior retraction.

Thus statistically significant difference in molar anchorage loss was observered when compared with the study and the control group. The undecorticated posterior segment can effectively act as an anchorage module. Although not statistically significant, there was no anchorage loss during the first two months the anchor loss was found to gradually increase by the end of 4$^{th}$ month of retraction. Further anchor loss could not be assessed as most of the cases showed completion of space closure by the end of 4th month in the corticotomy(study) group. The molar anchor loss did not vary significantly between the monthly intervals assessed in the control group.

Though corticotomy assisted orthodontic treatment (CAOT) has beneficial outcome in terms of duration of treatment its limitations in cases of active periodontal disease or gingival recession should be a consideration. In our study in one sample the mandibular canine roots were completely exposed with dehiscence which was covered with alveolar grafting. Initially there was gingival recession in that particular tooth which eventually underwent repair and resulted in improvement.

Although CAOT may be considered a less-invasive procedure than osteotomy-assisted orthodontics or surgically assisted rapid expansion, there are a few reports sighting interdental bone loss and loss of attached gingiva, to periodontal defects observed in some cases with short interdental distance. Subcutaneous hematomas of the face and the neck have been reported if intensive corticotomies were performed. Long-term effect of CAOT on root resorption requires further study. In addition, some post-operative swelling and pain has also been reported for several days.

# SUMMARY AND CONCLUSION

The present clinical study was conducted to evaluate the efficiency and treatment outcome of a modified Corticotomy assisted en-masse retraction with the conventional method of en-masse retraction in bimaxillary protrusion patients.

The following conclusions were drawn from the present study:

1. Extraction space closure of about 93.5% in the maxilla and 92.6% in the mandible was achieved by the fourth month of retraction in the corticotomy group- Study group.
2. Only 54.5% of extraction space closure in the maxilla and 51.7% in the mandible was achieved by the fourth month of retraction in the conventional group- Control group.
3. The rate of retraction accelerated during the first two months of retraction.
4. The rate of retraction with corticotomy assisted orthodontics was twice as quicker when compared to the control group.
5. There was better anchorage control with the undecorticated molar segment during the retraction period but the amount of anchor loss was found to increase as time period advanced.

Based on the outcome of this study it is reasonable to conclude that Corticotomy assisted retraction drastically reduces the overall duration of Orthodontic treatment. It is particularly useful in maximum anchorage cases since by Selective decortications the anchorage segment can be made virtually stationary and the entire extraction space can be utilized for retraction. However post operatively, the procedure does bring about transient inflammation and localized swelling.

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# ANNEXURE I

## Participant Informed consent form

Participant O.P number: ……………………..

Title of the study: **EFFICIENCY AND TREATMENT OUTCOME OF CORTICOTOMY ASSISSTED ORTHODONTICS.**

The content of the information sheet dated …………… that was provided had been carefully read by me/ explained in detail to me, in language that I comprehend and fully understood by me.

I have been explained about the treatment to correct my forwardly placed teeth that involves a surgical intervention of intentional cuts on the bone over the front teeth region along with the placement of human bone graft material. The nature and the purpose of the study , it's potential risk and benefits like swelling and pain, duration of the treatment, maintenance of the appliance and keeping of regular prescribed appointments had also been briefed. I agree with the above treatment plan and I give permission for these individuals who looked at my treatment as responsible individuals from Ragas Dental College and hospital to have access to my records.

I agree to take part in the above study.

……………………………..

Signature/ Left thumb impression Date & place:

Name of the participant: ________________________________ Age/ Sex: _____________

Complete postal address: ________________________________

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